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IBM 7090/7094 IBSYS Operating System Generalized Sorting System

This publication provides a detailed description of the IBM 7090/7094 Generalized Sorting System #7090-SM-922. The system sorts fixed-length or variable-length records written in either binary or decimal mode. The control fields of the records may be signed or unsigned and may be sorted in ascending or descending order using either the scientific or commercial collating sequence. Sort also incorporates a complete merge program, which merges previously sorted files. The Sorting system operates under the 7090/7094 IBSYS System Monitor.

Preface

This publication provides a detailed description of the IBM 7090/7094 Generalized Sorting System (Sort). Chapter 1 describes the characteristics, features, and capabilities of the system. Chapter 2 describes the structure of Sort. This chapter includes the four main phases of Sort, some operational procedures, and a system flow chart. Control cards for operating under the IBSYS System Monitor and control cards for the actual sorting procedures are described in Chapter 3. Chapter 4 contains a listing of the subprograms loaded during each phase of Sort and a discussion of subprogram loading procedures.

The structure of Sort files and records is explained in Chapter 5. Chapter 6 covers exits in the Sort which are available for user modification subroutines. Flow diagrams are presented with the text to assist in the utilization of this information. In Chapter 7, operator and programmer messages are listed and explained, and appropriate operator action is indicated. Chapter 8 lists the core-storage locations that are allotted to the COMMON parameter entries. In Chapter 9, procedures for updating, editing, and modifying the 7090/7094 Sorting System are described.

It is assumed that the reader has a basic understanding of the IBM 7090 or 7094 Data Processing System, especially in relation to input/output devices and magnetic tape records. No knowledge of symbolic programming is required to execute Sort except when it is desired to introduce program modifications.

The reader may find the following IBM publications useful:

IBM 7090/7094 IBSYS Operating System: System Monitor (IBSYS), Form C28-6248

IBM 7090/7094 IBSYS Operating System: Input/Output Control System, Form C28-6345

IBM 7090/7094 Programming Systems: FORTRAN II Assembly Program (FAP), Form C28-6235

IBM Standard Tape Label, Form C28-8142

The minimum machine requirements needed by Sort are given below. All references to magnetic tape units apply to both 729 Magnetic Tape Units and 7340 Hypertape Drives.

An IBM 7090/7094 (including 7094 II) Data Processing System with an IBM 7302 or 7302-1 Core Storage Unit (32K).

A 729 Magnetic Tape Unit, 7340 Hypertape Drive, 1301 Disk or 7320 Drum Storage as the system library unit.

A system input unit (SYSIN1), which may be a magnetic tape unit or an on-line card reader.

A magnetic tape unit for each file of information to be sorted or merged. A file may be contained on more than one reel of magnetic tape.

At least four magnetic tape units, divided equally between any two channels.

An optional system output unit (SYSOU1) for off-line messages and unreadable records. It must be a magnetic tape unit.

An optional system checkpoint unit (SYSCK2) for checkpoints, dictionaries, and unreadable records (if SYSOU1 is not used).

An on-line printer.

This information is summarized in the following table:

SYSTEM UNIT FUNCTION	REQUIRED	CAN BE					
		729	7340	1301	7320	711	716
System Library Unit (SYSLB1)	Yes	X	X	X	X		
System Checkpoint Unit (SYSCK2)	Optional	X	X				
System Input Unit (SYSIN1)	Yes	X	X			X	
System Output Unit (SYSOU1)	Optional	X	X				
System Peripheral Punch (SYSPP1)	No						
System Card Reader (SYSCRD)	Optional						
System Printer (SYSPRT)	Yes						X
At least four tape units	*	X	X				
System Utility Unit 1 (SYSUT1)	**	X	X				
System Utility Unit 2 (SYSUT2)	**	X	X				
System Utility Unit 3 (SYSUT3)	**	X	X				
System Utility Unit 4 (SYSUT4)	**	X	X				

* At least two tape units on each of two channels.

** May be used as any of the four required tape units if specified by Sort control cards.

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The IBM 7090/7094 Generalized Sorting System (Sort) is a multiphase program designed to offer the user flexibility in processing files. Sort accepts, as input to be sorted, either fixed-length or variable-length records written in either binary or decimal mode. The control fields of the records may be signed or unsigned and may be sorted in ascending or descending order using either the scientific collating sequence or the commercial collating sequence. The records may be sorted on up to 200 control fields. The combined lengths of these control fields may be up to 2,000 words long (the maximum size of a logical record or tape record allowed by the program). Input files must be on either 729 or 7340 magnetic tapes. The tapes are rewound by the Sort system before being read.

The 7090/7094 Sort is designed to operate under the IBSYS Operating System, which controls the availability of all input/output devices. The parts of IBSYS used by Sort are IBNUC and IOEX; Sort provides its own read/write routines and buffering schemes.

System Capabilities

The 7090/7094 Generalized Sorting System enables the user to:

1. Sort or merge records on 729 Magnetic Tape Units or 7340 Hypertape Drives or on a combination of these.
2. Accept files written in either binary or decimal mode.
3. Sort or merge fixed-length or variable-length data records, which may be either blocked or unblocked.
4. Perform up to an eight-way merge if the IBSYS Availability Table is large enough. Maximum Sort capacity is seven full reels of blocked data on tape, written in 800 cpi density if 729 tapes are used during Merge Phase. (A full reel of 729 tape is assumed to be 2,300 feet long between beginning-of-tape and end-of-tape markers. A full reel of 7340 Hypertape is assumed to be 1,700 feet long. The number of data records on each full reel depends on the logical record length, the blocking factor, and the tape density. Sort capacity is determined by the type of tape units being used for merging. If these are mixed 729 and 7340 units, the capacity is based on that of a 729 unit.)
5. Sort and/or merge signed or unsigned control fields in ascending or descending order.
6. Sort and/or merge in commercial or scientific collating sequence.

7. Merge previously sorted data with a current sort run.

8. Insert modification subroutines at specified entry points.

9. Perform a merge operation.

System Characteristics

The 7090/7094 Sort system is composed of separate subprograms (modules), supplied as a series of blocked card images on the IBSYS system tape. The subprograms are assembled in relocatable form so that only those subprograms needed for a particular Sort run are loaded from the system unit at the time each phase of the Sort is loaded.

The Edit Phase of Sort determines from control card parameters which subprograms are required for a given run. The control cards are fully described in Chapter 3.

The modular structure of Sort allows the user flexibility in introducing routines into the Sort system to permit such operations as summarization, deletion, lengthening, and shortening of records. These routines can be located on any of the SYSUNI tapes or in the card reader, and are loaded and handled in the same manner as the subprograms supplied with the 7090/7094 Sort System.

The Merge Program

A complete merge program is incorporated in Sort, making a separate merge program unnecessary. When a merge run is executed, only the Final Merge Phase subroutines are used. This program is also used during a sort run to complete the merging of strings of records. A string is a group of logical records in either ascending or descending order. In a sort-and-merge run, it is possible to merge previously sorted records with records currently being sorted.

Input/Output Units

For merging, Sort requires 2M tapes, where M is the order of merge. The tape units may be all 729, all 7340, or half 729 and half 7340 units, but they must be evenly divided between two channels. The order of merge, that is, number of files that can be combined to form a single file during the merge program, is determined by the user, usually on the basis of tape unit availability. An increase in the order of merge is ad-

vantageous when it saves time by reducing the number of merge passes necessary to complete the sort. The maximum order of merge allowed by Sort is eight.

An additional tape unit is required if the Sort system is on tape rather than disk or drum storage. If the control cards are on tape, another tape unit is required. Otherwise, control cards can be read from the on-line card reader. Sort always reads control cards from the unit attached as `SYSDIN1`.

Checkpoint records give the status of core storage at a given point during the execution of Sort. These records are written on the unit attached as `SYSCCK2` unless either the `NOCCKPT` option is specified on the `OPTION` control card or there is no tape attached as the `SYSCCK2` function. If `9PAC` dictionaries are present, they are saved on `SYSCCK2` if it is attached. Otherwise, the dictionaries are not saved.

Unreadable records that cannot be processed by Sort are normally saved on the `SYSDOUT` unit if one is attached. If the `NOF` option is specified, unreadable records are saved in the fourth file of the `SYSCCK2` unit, if attached.

Initiating the Sort System

The Sort system occupies two consecutive files on the `IBSYS` system unit. If this unit is a tape device, the Sort system uses its own loader to load the relocatable subprograms. If the `IBSYS` system unit is a disk or drum, the `IBSYS` System Loader, `SYSLDR`, is used for loading.

If the `IBSYS` System Monitor control cards are on a tape unit attached as `SYSDIN1`, sense switch 1 must be up when the system run is started. If the control cards for `IBSYS` are in the card reader, sense switch 1 must be down at the start and left down until the `IBSYS` System Monitor begins reading control cards from the card reader. If the Sort control cards are in the card reader, the card reader must be attached as `SYSDIN1`. If the cards are on tape, the tape unit must be attached as `SYSDIN1`.

If the `IBSYS` system is on tape unit A1, clear core storage and press the Load Tape button to start the system. If `IBSYS` is on any other unit—whether tape, disk, or drum—place a start card in the card reader, clear core storage, and press the Load Card button.

Optional Program Features

The following options, which may be specified on Sort control cards, are available to the user during execution of a sort and/or merge run. For further information, see “Sort Control Cards.”

The CKSUMS Option: If specified, a 36-bit logical check sum is computed for each logical record during a sort run. The contents of all words in the record, in-

cluding the record-sequence word when it is used (see “The EQUALS Option”), are logically added. The sum is placed in a word that follows either the record-sequence word if it is requested or the last word of the logical record if the records are fixed-length. For variable-length records, the check sum is placed in the word immediately preceding the record control word (the first word of the logical record). The check-sum word is retained during the entire sort and checked each time the record is read into core storage. However, it is deleted before the final output is written. The `CKSUMS` option cannot be used with a merge run or with a combined sort-and-merge run.

The EQUALS Option: If this option is specified, logical records having identical control fields (on which the records are sorted) are written on the output files in the order in which they appeared on the input file. Sort does this by appending a record-sequence word to each logical record. The record-sequence word follows the last word of a fixed-length logical record but precedes a variable-length record, including the check-sum word if one is present. The record-sequence word is retained during the entire sort but deleted before the final output is written. The `EQUALS` option cannot be used with a merge run or with a combined sort-and-merge run.

The VARIABLE BLOCKING Option: If this is specified, short input tape blocks are accepted by the fixed-length portion of the program if their length is a multiple of the length of the logical input record.

The NOCKPT Option: When specified by this option, checkpoint records, which are normally written by Sort, are not written, even though a unit is attached as `SYSCCK2`.

The BUFFER Option: Normally, fixed-length records are read into core storage by a “scatter-read” process. This option causes records to be read into buffers instead, thereby providing access to the records for modification.

The RELCOM Option: The area reserved for the `COMMON` parameters of the program is usually placed in upper core storage, leaving space only for the `IOEX` off-line message writer, `SPOUT`. This option provides for relocating the `COMMON` area downward so the user can have space between the `COMMON` area of Sort and `SPOUT` (for example, for location of his installation accounting routine).

The DELETE Option: If this option is taken by including one or more `DELETE` control cards, Sort deletes from the file any record containing the information specified on the `DELETE` control card(s).

The TAPES Option: When this option is specified, the table of tape units to be used is printed on-line, and the system pauses for the operator to ready the

tapes. The tape table is *always* printed off-line unless the **NOF** option is specified.

The MAPS Option: The loading locations of the relocatable programs used during a sort and/or merge run are printed on-line if this option is specified. However, unless the **NOF** option is taken, they are *always* printed off-line, regardless of the **MAPS** option.

The CARDS Option: Columns 7-72 of the Sort control cards are printed on-line if this option is taken. Unless the **NOF** option is specified the contents of these columns are *always* printed off-line, regardless of the **CARDS** option.

The HISTORY Option: Calculated parameters, counts of the number of records sorted during each pass, and messages regarding the progress of the program are printed on-line when this option is taken. Unless the **NOF** option is specified these messages *always* appear off-line, regardless of the **HISTORY** option.

The NOF Option: If a tape unit is assigned as **YSOU1**, all messages are written on this unit, whether or not they also appear on-line. Writing on **YSOU1** is suppressed either by specifying the **NOF** option or by not attaching a tape unit as **YSOU1**. Unreadable records are normally written on **YSOU1**. If they cannot be written there because of the **NOF** option or because the unit is not attached, they are written in the fourth file of **SYSCK2** if it is attached.

Collating Sequences

Sort permits the use of either the scientific or commercial collating sequence.

In Table I, column one shows the characters of the scientific sequence in ascending order. Beside each character, in column two, is its octal representation in core storage. Column three shows the characters of the commercial sequence in ascending order. For the commercial sequence, the octal representation in column two is used for sorting. For example, if the characters to be compared are 4 and K, the comparison in the scientific sequence would be between 04 and 42. If the commercial collating sequence had been requested, the comparison would be between 56 and 31.

If descending order is requested, the sorting equivalent in the table is complemented. Thus, for the example using 4 and K, the comparison would be between 73 and 35 if the scientific sequence were requested, and between 21 and 46 if the commercial sequence were requested.

The table used for the conversion when the commercial collating sequence is requested appears in the **XTRACT** subprogram beginning at symbolic location **TABLE** and occupies 64 locations. The first two octal digits of each word contain the sorting equivalent of

the commercial sequence characters in the scientific sequence order. For example, the twentieth character in the scientific sequence is C. The twentieth entry in **TABLE** (in the **XTRACT** subprogram) has 20 in the first two octal digits. Therefore, 20 is the sorting equivalent of C in the commercial sequence order. The conversion table in **XTRACT** may be changed if it is desired to alter permanently the sequence that results whenever the commercial collating sequence is requested.

Table I: Sorting Equivalents for Scientific and Commercial Sequences

SCIENTIFIC SEQUENCE	SORTING EQUIVALENT	COMMERCIAL SEQUENCE
0	00	Blank
1	01	.
2	02) or □
3	03	≡
4	04	&
5	05	\$
6	06	*
7	07	—
8	10	/
9	11	,
None	12	% or (
#	13	#
@	14	@
None	15	+0
None	16	A
None	17	B
&	20	C
A	21	D
B	22	E
C	23	F
D	24	G
E	25	H
F	26	I
G	27	—0
H	30	J
I	31	K
+0	32	L
.	33	M
)	34	N
None	35	O
None	36	P
≡	37	Q
—	40	R
J	41	≡
K	42	S
L	43	T
M	44	U
N	45	V
O	46	W
P	47	X
Q	50	Y
R	51	Z
—0	52	0
\$	53	1
*	54	2
None	55	3
None	56	4
None	57	5
Blank	60	6
/	61	7
S	62	8
T	63	9
U	64	None
V	65	None
W	66	None
X	67	None

Table I: Sorting Equivalents for Scientific and Commercial Sequences (Cont.)

SCIENTIFIC SEQUENCE	SORTING EQUIVALENT	COMMERCIAL SEQUENCE
Y	70	None
Z	71	None
≠	72	None
,	73	None
(74	None
None	75	None
None	76	None
None	77	None

Algebraic Sort

An algebraic sort should only be used with a scientific collating sequence. When an algebraic sort is requested, the sign bit must be considered, as well as whether the sort is to be in ascending or descending order. To sort the algebraic control fields properly, XTRACT does the following:

1. If the sort is in ascending order and the sign is plus, the sign is changed. Thus, for example, the bits 00101 become 10101.

2. If the sort is in ascending order and the sign is minus, the whole field is complemented. Thus, 10101 becomes 01010.

3. If the sort is in descending order and the sign is plus, the field, except for the sign bit, is complemented. Thus, 00101 becomes 01010.

4. If the sort is in descending order and the sign is minus, the field is unchanged. Thus, 10101 remains 10101.

Logical Sort

A logical sort may use either the scientific or commercial collating sequence. If the commercial collating sequence is specified, the length of each field must be a multiple of six bits. Records are sorted as defined by the collating sequence charts (Table I) without adjustment for signs of numeric fields.

Figure 1 presents a very general picture of the XTRACT routine. It is a graphical illustration of the material described in the preceding paragraphs.

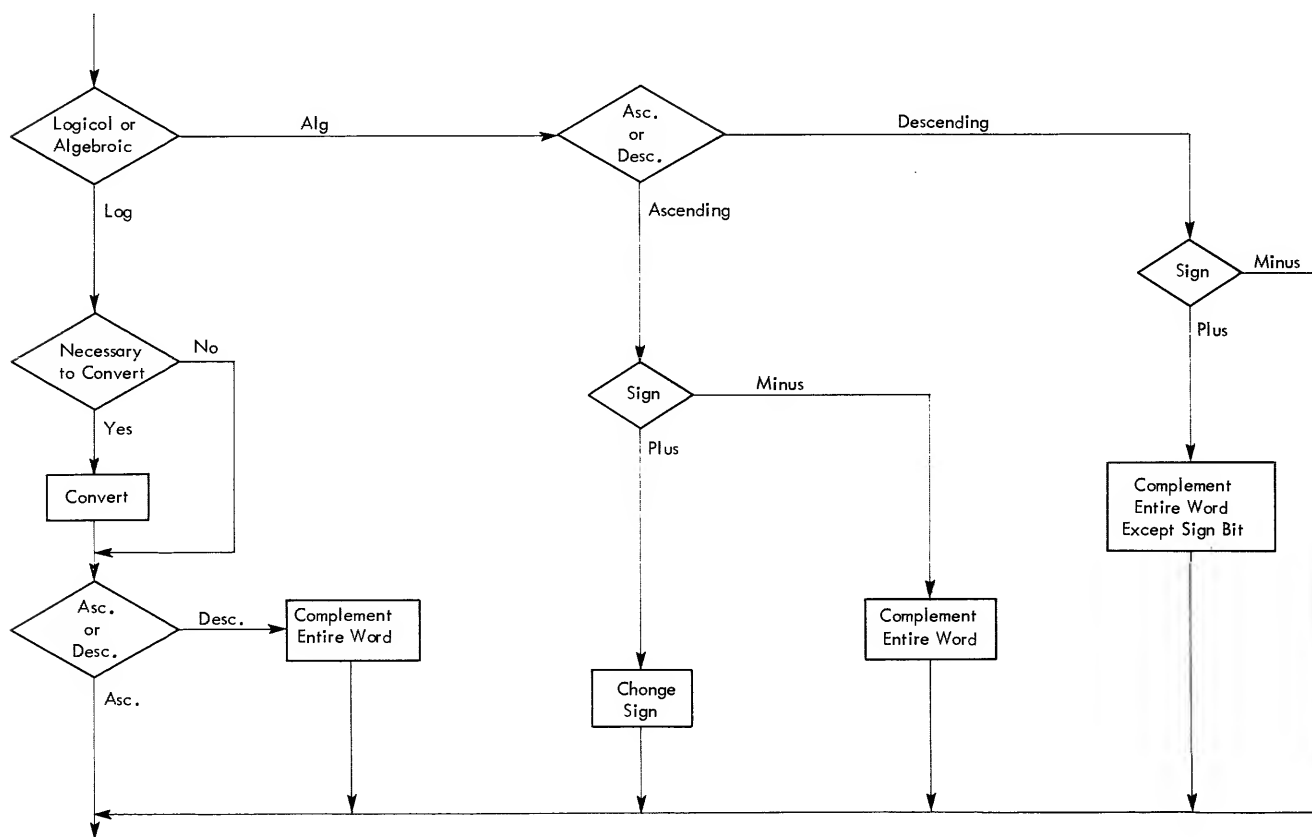


Figure 1. XTRACT Routine

Sort is divided into four distinct phases: the Edit Phase, the Internal Sort Phase, the Merge Phase, and the Final Merge Phase.

The system also contains the Sort Monitor and the Postprocessor. The Sort Monitor communicates with IBSYS and maintains phase-to-phase control over the running of the program. Sort Monitor initializes the Sort system by loading Edit Phase, which reads all control cards up through the card following the END card of a given Sort run. After the Postprocessor prints out information on the completed Sort run, the last control card previously read (i.e., the card following the END

card) is analyzed and the action taken is determined as follows:

If this card is any of the following, Sort Monitor reloads Edit Phase and retains control.

1	16
\$EXECUTE	SORT
\$ID	
\$PAUSE	
any Sort control card	

If the next control card after the END card is any of the following, Sort Monitor returns control to the IBSYS System Monitor and does not reload Edit Phase.

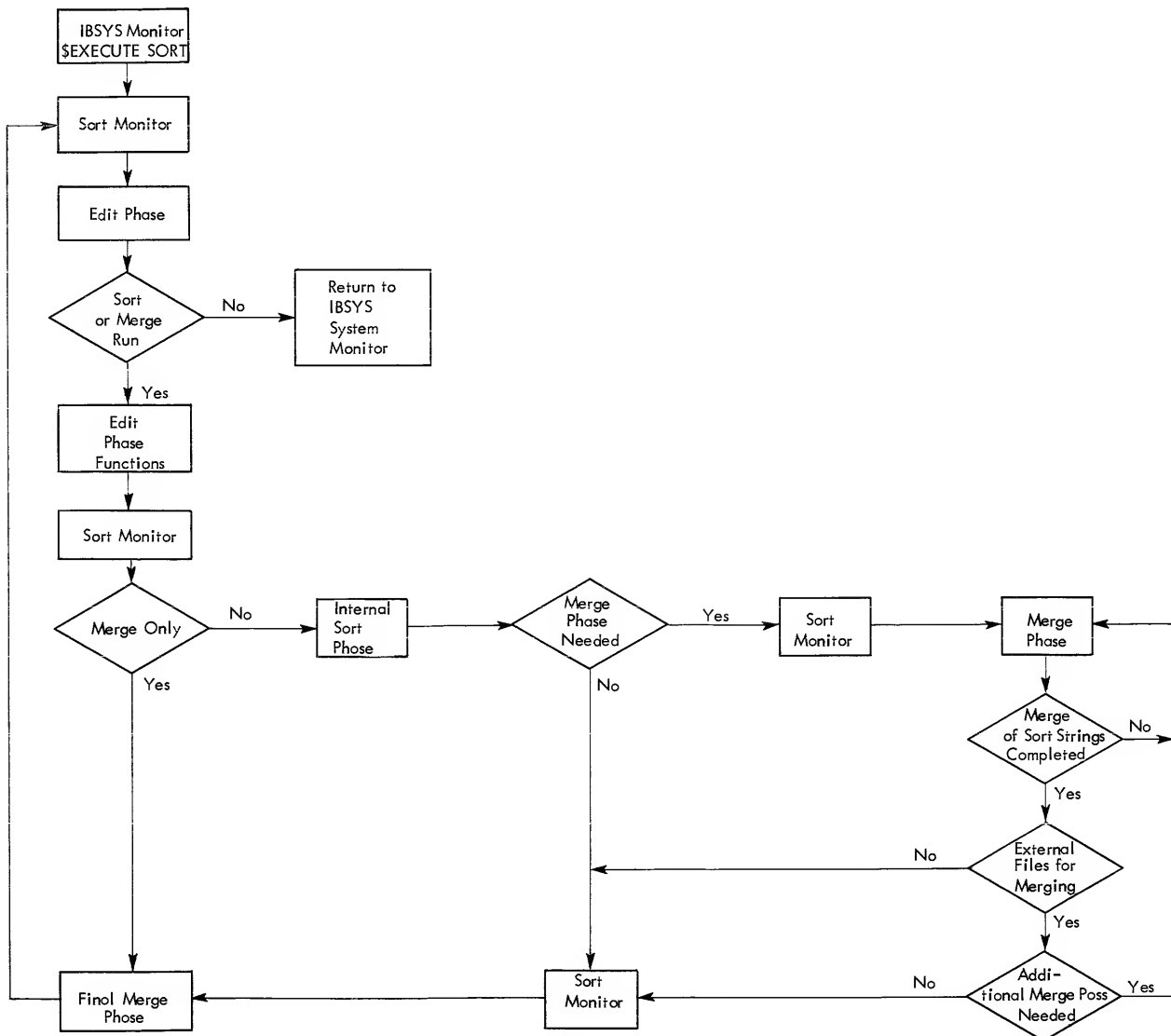


Figure 2. Flow of Control for 7090/7094 Sort System

1	16
\$JOB	
\$EXECUTIVE	anything but SORT
\$IBSYS	
\$STOP	

If the card following the END card is none of the eight given in the preceding text, Sort Monitor reloads Edit Phase which prints the following error message:

NOT A SORT CONTROL CARD

Flow of Control

Figure 2 shows the system flow of control for the 7090/7094 Generalized Sorting System.

Edit Phase

The Edit Phase is the first phase of Sort. It is called by the Sort Monitor and performs the following functions:

Card Analysis: During Edit Phase, the control cards are loaded into core storage and the parameters are analyzed. Card analysis consists of the following:

1. Control cards are checked for invalid characters.
2. Control cards are checked to verify that all required parameters are supplied to the system and that no invalid parameters are given. Given parameters are also checked for the proper format.
3. Messages are printed on the on-line printer to inform operator of errors or possible errors in control cards.
4. After being checked, the information is placed in relocatable COMMON tables.

Building Program Lists: Edit Phase determines which subprograms on the system tape will be required in subsequent phases. The names of these programs are placed in program lists for the Internal Sort, Merge, and Final Merge Phases. These program lists are used by the Sort Monitor to load the necessary subprograms for each phase.

Calculating Internal Parameters: The internal parameters used by the other three phases are calculated by the Edit Phase and placed into relocatable tables (the COMMON area) for later use.

Internal Sort Phase

The Internal Sort Phase is a one-pass phase. Its function is to arrange input records in sequenced strings (which are groups of logical records appearing in an order according to specified control fields and may be one or several output blocks long). Each output block is as large as can be accommodated by the Merge Phase. The output of Internal Sort Phase is divided among the number of tapes represented by the order

of merge (which is equal to the number of files that can be combined into a consolidated file during a merge operation).

This phase produces sequenced strings by a modified continuous merge process. Records are read into a Record Storage Area and are sorted in this area. A smaller number of additional records are then read into an auxiliary area and are there sorted and merged with the records in the Record Storage Area. A number of records equal to the number of sorted records is then selected and written as output. For a sort of fixed-length records, an equal number of records is simultaneously read in to continue the process. For a sort of variable-length records, additional records to be sorted are read into the core-storage space made available as a result of records being written out. The number of records read in varies with the record size.

Unless the BUFFER option is requested, fixed-length records are read into the Record Storage Area by a "scatter-read" procedure and are not moved during the internal sort processing. Instead, sorting and merging are done using tag (or pointer) tables. When selected for output after sorting and merging, the records are written by a "scatter-write" procedure. Variable-length records, and fixed-length records if the BUFFER option is specified, are read in by a "buffer-read" procedure. By this method, each logical record is moved from the input buffer to the Record Storage Area. There, processing is performed in a manner similar to that used with a "scatter-read" procedure.

The selection of records to be written is made in such a way as to produce the longest possible strings. The method used by Internal Sort Phase takes advantage of any sequences already existing in the file to produce unusually long strings. For random records, strings containing about twice the number of records contained in the Record Storage Area can be obtained. Since the number of strings formed in a given file varies inversely with the length of the strings, longer strings reduce the number of merge passes necessary to complete the sort.

Merge Phase

During the Merge Phase, the sequenced strings generated by the Internal Sort Phase are merged in succeeding passes until the number of strings is no greater than the merge order. If the number of strings produced by the Internal Sort Phase is not initially greater than the merge order, the Merge Phase is bypassed.

Sort uses the balanced merge technique, with half of the merge tapes on one channel and half on the other. Available core storage is divided into $2M + 3$

merge areas (where M is the merge order), each area being large enough to contain one merge block. Merge blocks are read into these areas, and the records are written from these areas as they are merged. After all records have been written out from an area, another block of records may be read into the area.

To initialize this phase, one merge block is read into a merge area from each of the tapes on the first merge channel. After these blocks have been read, merging begins. At the same time, another block is read from each tape. When enough records have been merged to produce one merge block, the block is written as merging continues.

The records from the first string on each merge tape produced by Internal Sort Phase are written as one string on a tape on the second merge channel after the records have been merged. Then the records in the second string on each merge tape are merged and written on another tape on the second merge channel. This process continues until all records have passed through the merge. If any merge tape now contains more than one string, another merge pass follows. When none of the merge tapes contains more than one string, the phase ends.

The Merge Phase is designed to handle any merge order from two through eight. A large order of merge may reduce the number of passes required for the sort, thus reducing total execution time of the run. However, since the Merge Phase must handle $2M + 3$ blocks at once, the size of the merge block may be smaller for a large merge order than for a small one. This causes more interrecord gaps on the merge tapes and slower input/output operations.

Final Merge Phase

During the Final Merge Phase, the strings produced by the Merge Phase, or by the Internal Sort Phase if the Merge Phase is bypassed, are merged. Merging occurs in the manner described for the Merge Phase. The strings are written in the format specified by the output FILE card (see "SORT Control Cards").

In this phase, $2M + 2$ areas are used for reading, and two output buffers, each the size of an output block, are used alternately for writing.

During a sort-and-merge run, the external files are merged with the sorted file by this phase. In a straight merge run, this phase follows Edit Phase; the Internal Sort and Merge Phases are omitted.

Checkpoint and Restart Procedure

Unless the NOCKPT option is specified on the OPTION card, checkpoints are written at the following points during execution of a Sort run:

1. After each reel of input of the Internal Sort Phase
2. At the end of the Internal Sort Phase
3. After each pass of the Merge Phase
4. After each reel of output of the Final Merge Phase

When a checkpoint is taken, core storage is saved by being written on the checkpoint tape (SYSCK2).

To restart the Sort run, the following control cards are necessary:

1	7	16
\$EXECUTE		SORT
	RESTART	
	END	

The Edit Phase of 7090 Sort reads the RESTART card and transfers control to the Hystar subprogram, which initiates the restart procedure. SYSCK2, the checkpoint tape, is positioned; the checkpoint file is read into core storage; core storage is restored; and the tapes are repositioned.

Deblock and Dump

Unreadable records, which cannot be processed by Sort, may be written out for examination by the user. If the NOF option has not been specified on the OPTION card, these records are written on SYSOU1 if it is attached. Specifying the NOF option causes placement of these records in the fourth file of SYSCK2 if it is attached. If neither SYSOU1 nor SYSCK2 is attached, unreadable records are not written.

If the Sort run is to be deleted when an unreadable record occurs, the UNRDBLK option must be specified on the OPTION control card.

The format for the dumped records is determined by the mode specified on the input FILE card. If binary mode is specified, the record is written in octal format, 12 digits per word, with blanks separating the words. If decimal mode is specified, the record is written in decimal format, six characters per word, with blanks separating the words. If the octal character 72 (representing a record mark) is encountered when dumping decimal records, it is replaced by an equals (=) sign. The invalid octal characters, 15, 16, 17, 35, 36, 37, 55, 56, 57, 75, 76, and 77, are replaced by an asterisk (*).

Chapter 3. Control Cards

IBSYS System Monitor Control Cards

The Generalized Sorting System recognizes six IBSYS System Monitor control cards. If Sort reads a card which is neither one of these six System Monitor cards nor a Sort control card it prints the message NOT A SORT CONTROL CARD. Options are then given either to ignore the card and continue or to delete the Sort.

When Sort reads one of the six valid System Monitor control cards, it takes the appropriate action, as indicated after each card below:

1	16
\$EXECUTE	SORT

This card calls Sort and causes control to be transferred from the IBSYS System Monitor to the Sort Monitor. If this card is read by Sort, the Sort Monitor retains control and Sort reads the next card from the system input unit (SYSIN1).

1	16
\$EXECUTE	sysnam

If this card is read by Sort and the variable field entry sysnam (the identification or name of a system in the System Position Table) is anything but SORT, control is returned to the IBSYS System Monitor for execution of sysnam.

1
\$IBSYS

When Sort reads this card, it returns control to the IBSYS System Monitor.

1
\$ID

Upon reading a \$ID card, Sort transfers control to the installation accounting routine.

1
\$STOP

This card causes all processing to stop.

1
\$JOB

This card causes Sort to return control to the IBSYS System Monitor.

If the Sort system cannot proceed to completion and is deleted, all subsequent Sort runs will be automatically deleted until a \$JOB card is processed.

SORT Control Cards

For a file to be sorted, certain information must be supplied to the Sort system. This includes a description of the logical records, the input and output files, and the control fields on which the records are to be sorted. Other information dealing with options, labels, and modifications may also be needed. Information contained in columns 7-72 of the following thirteen control cards provides complete control of the Sort system.

CARD	DESCRIPTION
FILE	Defines file characteristics.
SORT	Defines the sort.
RECORD	Defines logical record(s).
MERGE	Defines the merge.
CHANNELS	Specifies the input, merge, and output channels.
LABEL	Specifies nonstandard labels.
OPTION	Lists the options desired.
MODIFICATION	Specifies the names of modification programs.
DELETE	Specifies records to be deleted from a file.
OVERFLOW	Skips initial records.
RESTART	Initiates restart procedure.
REMARK	Causes remarks to be printed.
END	Indicates end of control card deck.

In a normal Sort run (one with no options or unusual conditions specified), only the FILE, SORT, CHANNELS, RECORD, and END cards are needed.

The order of the fields on a Sort control card is not critical provided the first field on the card is the card name or identifier.

Control Card Notations

Certain special characters and specified formats are used either to define or to separate fields or subfields.

1. When Sort reads a control card, only the first three BCD characters of any field are meaningful to the program. Any additional characters before the next slash or comma are interpreted as comments. The name (or first three characters) of each field is its field definer.

Examples

SORT need only be SOR.

MOD effects the same action as MODIFICATION.

2. The slash (/) follows all field definers associated with a parameter.

3. Parentheses () are used when more than one parameter is needed for a field definer. The left parenthesis follows the slash, and the right parenthesis is used when the end of the parameters is reached.

4. The comma (,) is used in any of the following three ways:

- To separate one field definer and its parameters from another field definer and its parameters
- To separate one parameter from another when they are enclosed within parentheses
- To separate the name of the card from the definers and parameters on the card

5. An X in column 6 is used to indicate a continuation of the control card. This card must immediately follow the control card which it continues.

When a control card and any related continuation cards are scanned, the information beginning in column 7 of each continuation card is interpreted as a continuation of the preceding card. It is not necessary that the first 72 columns of a card be completely used before a continuation card is employed, nor is it required that a given field be completed before column 73 is reached. The text of a continuation card may begin anywhere after column 6 and before column 73.

Specification of field parameter lengths following the NAME or INDENT fields (see FILE, LABEL, and DELETE cards) may require use of a continuation card. In these instances, the information beginning in column 7 of the continuation card follows that in column 72 of the previous card.

6. Material given in brackets [] represents an optional field, which may be either specified or omitted as desired. If the field is not specified, either the standard option, which is underlined>, is taken or, if no option is underlined>, the field itself is not being used.

7. Braces {} define material requiring the user to make a choice if the associated field is used.

8. Upper-case letters or words must appear in the form specified when they are used.

9. Lower-case letters or words represent generalized quantities whose particular value must be specified by the user if the associated field is used.

It is not necessary that control statements (i.e., a control card and its continuation cards, if any) be arranged in any specific order. The only restriction is that the END card must be the last control card.

For each sort and/or merge run, the number of times each control card may be used is given below. Each control card may use one or more continuation cards.

CONTROL CARD	NUMBER OF TIMES PERMITTED
RESTART	1
SORT	1
MERGE	1
RECORD	1
OPTION	1
LABEL	1
OVERFLOW	1
CHANNELS	1
END	1
FILE	9
MODIFICATION	50
DELETE	100
REMARK	Any number

Input FILE Card

The input FILE card describes the physical characteristics and organization of an input data file. One input FILE card is required for a sort run. For a merge run or a sort-and-merge run, one input FILE card is required for each input file.

The complete input FILE card has the following format:

```

1 7
FILE, INPUT/n, BLOCKSIZE/n [ , REELS/ { 1/n } ]
[ , MODE/ { D/B } ] [ , DENSITY/ { H/L } ] [ , CKSUMS ]
[ , BLKSEQ ] [ , CKPT/ { S/N } ]
[ , DICTIONARY [ / { H/L } ] ]
[ , LABEL/ { S/N } [ { H/L } ] ] [ , SERIAL/n ]
[ , RLSEQ/n ] [ , NAME/nHxx . . . xn ]

```

The fields of the input FILE card are defined as follows:

,INPUT/n

This field defines the card as an input FILE card, where n is a number whose maximum length is four digits. This number is assigned to the input file and used wherever this file is referenced, such as on the SORT card.

,BLOCKSIZE/n

For fixed-length records, n is the number of words in an input block. The number n must be a multiple of the input record length and does not include the check-sum block-sequence word.

For variable-length records, n is the number of words in the largest block of input records. If a block longer than n but not longer than 2,000 words is read, a message is printed and the block is accepted.

```

[ , REELS/ { 1/n } ]

```

The number of reels in the file is designated by n. If the file is to be processed under label control, the letter L rather than a number is specified. For a one-reel file, the field may be omitted.

```

[ , MODE/ { D/B } ]

```

D indicates the file is to be read in decimal mode; B, in binary mode. If the input FILE card specifies a standard label, the mode designation in the label takes precedence over this field.

```

[ , DENSITY/ { H/L } ]

```

If L is specified, the 729 tape unit is set to low density. H indicates high density. For a high-density 729 file or for a 7340 Hypertape file, the field may be omitted. If the input FILE card specifies a standard label; the density designation in the label takes precedence over this field.

```

[ , CKSUMS ]

```

This field specifies that the left half of the last word of each tape block contains a folded check sum of the block. This check sum is recomputed, and, if the two values are different, a message is printed. The CKSUMS option is permitted only in binary files.

```

[ , BLKSEQ ]

```

This field specifies that the right half of the last word of each tape block contains a block-sequence number. The num-

$$\left[, \text{CKPT} / \left\{ \begin{matrix} S \\ N \end{matrix} \right\} \right]$$
$$\left[\text{, DICTIONARY} \left[/ \left\{ \begin{array}{c} \text{H} \\ \text{L} \end{array} \right\} \right] \right]$$
$$\left[, \text{LABEL} / \left\{ \begin{matrix} S \\ N \end{matrix} \right\} \left[\left\{ \frac{H}{L} \right\} \right] \right]$$

[, SERIAL/n]

$$[\text{, RLSEQ/n}]$$
$$[, \text{NAME}/n\text{Hxx} \dots x_n]$$

The following are examples of typical input FILE cards:

```

1 7
FILE, INPUT/263, CKSUMS, REELS/5, RLSEQ/4,
{ DEN/L, BLO/2000, LAB/SH, DICT/H, BLK,
  SER/6, MODE/B, NAME/9HWAGE SORT

```

1 7
FIL, CKPT/S, DENSITY/H, REE/3, MOD/B,
BLOCK/850, SER/6, INP/263, LAB/SH

The complete output FILE card has the following format:

$$\begin{array}{l} \text{FILE, OUTPUT, BLOCKSIZE}/n \left[\text{MODE}/\left\{ \frac{D}{B} \right\} \right] \\ \left[\text{DENSITY}/\left\{ \frac{H}{L} \right\} \right] \left[\text{PADDING}/\left\{ \frac{H}{L} \right\} \right] \\ \left[\text{CKSUMS} \right] \left[\text{BLKSEQ} \right] \\ \left[\text{DICTIONARY} \right] / \left\{ \frac{H}{L} \right\} \\ \left[\text{LABEL}/ \left[\left\{ \frac{S}{N} \right\} \left\{ \frac{H}{L} \right\} \right] \right] \left[\text{SERIAL}/n \right] \\ \left[\text{RLSEQ}/\left\{ \frac{1}{n} \right\} \right] \left[\text{RETAIN}/n \right] \left[\text{NAME}/n\text{Hxx} \dots \text{x}_n \right] \end{array}$$

, BLOCKSIZE/n

For variable-length records, n designates the number of words in the longest block which is to be written. If there are records longer than n , they are written out singly. When $n = 1$, the output is unblocked.

$$\left[, \text{MODE} / \left\{ \frac{D}{B} \right\} \right]$$
$$\left[, \text{DENSITY} / \left\{ \frac{H}{L} \right\} \right]$$
$$\left[, \text{PADDING} / \begin{Bmatrix} \text{H} \\ \text{L} \end{Bmatrix} \right]$$

[, CKSUMS]

[, BLKSEQ]

This is an option for binary mode only. If this option is specified, a block-sequence number is written in the right half of a word immediately following the last word of the last record in the block.

$$\left[, \text{DICTIONARY} \left[/ \left\{ \frac{H}{L} \right\} \right] \right]$$

Specifying this option causes the 9PAC Dictionary indicated on the input FILE card to be written on the output file. If there is a file label, the dictionary must be written in the same density. In this case, density need not be designated. Note that a dictionary must have been specified on the input file to permit use of this option.

$$\left[, \text{LABEL} / \left\{ \frac{S}{N} \right\} \left[\left\{ \frac{H}{L} \right\} \right] \right]$$

When this field is specified, a label is written on the output file in either high (H) or low (L) density as indicated. If S is designated, the label is the 20-word IBM standard label if the output is on 7340 Hypertape. If the output is on 729 tape, the 14-word IOCS label is written unless the input file contains the 20-word IBM standard label. In this case, the 20-word IBM standard label is written on the output file. The parameter N defines a nonstandard label and refers to the one given on the LABEL card, if supplied, or to the label read from the input file.

$$\left[, \text{SERIAL} / n \right]$$

This field specifies that file serial number n is to be put in the label. Serial number n may not exceed five characters.

$$\left[, \text{RLSEQ} / \left\{ \frac{1}{n} \right\} \right]$$

This field specifies that the reel-sequence number in the output label begins with n or 1 and increases by 1 for each succeeding output reel used. If the field is not specified, reel sequencing begins with 1. The number n may not exceed four characters. If specified, this number will be used in message *OU01 when closing the output reels.

$$\left[, \text{RETAIN} / n \right]$$

The number n is put in the label field and specifies the number of retention days for the output file. The maximum length of n is three digits.

$$\left[, \text{NAME} / nHxx \dots xn \right]$$

If specified, the name (xx ... xn) is put in the output label. For 14-word labels, n must not exceed 18, and for 20-word labels, n must not exceed 10.

The following are examples of typical output FILE cards:

```

1 7
FILE, LAB/SL, BLO/1000, RET/120, DEN/H, PAD/H,
{ NAME/6HRESULT, BLKSEQ, OUTPUT, SERIAL/8,
  { RLS/1, MODE/B, CKSUMS }

```

```

1 7
FILE, OUT, RETAIN/63, MOD/D, DENSITY/L,
{ DICT/L, SER/, BLOCK/500, LAB/SH

```

RECORD Card

The logical record format is defined by the RECORD card. One RECORD card is required for each run. The complete RECORD card has the following format:

$$\left[\text{RECORD} \left[, \text{TYPE} / \left\{ \frac{F}{V} \right\} \right] , \text{LENGTH} / \left(n_1 \left[, n_2 \left[, n_3 \right] \right) , \text{FIELD} / n_1 \left[\left\{ \frac{C}{B} \right\} \right] \left[\left\{ \frac{U}{S} \right\} \right] , \dots , n_i \left[\left\{ \frac{C}{B} \right\} \right] \left[\left\{ \frac{U}{S} \right\} \right] \right) \right]$$

The fields of the RECORD card are defined as follows:

$$\left[, \text{TYPE} / \left\{ \frac{F}{V} \right\} \right]$$

The records to be sorted are either fixed-length (F) or variable-length (V).

$$, \text{LENGTH} / (n_1 \left[, n_2 \left[, n_3 \right] \right))$$

For fixed-length records, n_1 is the number of words in the input record. The number n_2 is the record length (in words) during the Merge Phase, i.e., during the writing of the output from the Internal Sort Phase and the input to the Final Merge Phase, and n_3 specifies the record length of the output from the Final Merge Phase. Numbers n_2 and n_3 are not needed unless the record lengths are to undergo modification during the sort. Any extra length needed for the check-sum and equals words (see "OPTION Card") is added by Sort to the lengths specified for this field. The number n_1 must be a factor of, and not exceed, the input block size. The number n_3 must be a factor of, and not exceed, the output block size.

For variable-length records, n_1 specifies the length (in words) of the shortest record and n_2 specifies the length of the longest record. An estimate of the record length occurring most frequently is indicated by n_3 . If this parameter is omitted, it is assumed that the longest record occurs most frequently. The record length control word, i.e., the first word of the record, must be included in counts n_1 , n_2 , and n_3 . The number n_2 must not exceed the input block size.

It is impossible to lengthen records in the Final Merge Phase. If lengthening is desired, it should be done during the Internal Sort Phase. Shortening of records may be done during either the Internal Sort or the Final Merge Phase.

$$, \text{FIELD} / (n_1 \left[\left\{ \frac{C}{B} \right\} \right] \left[\left\{ \frac{U}{S} \right\} \right] , \dots , n_i \left[\left\{ \frac{C}{B} \right\} \right] \left[\left\{ \frac{U}{S} \right\} \right])$$

Records must be divided into fields up to and including the last field needed for sorting, merging, or deleting.

To define the fields of a logical record, n_1 through n_i denote the lengths of the 1st through i th fields starting with the beginning of the record. This includes the record control word for variable-length records. Each field length is expressed either in bits (B) or in characters (C). When sorting files written in decimal mode, the field lengths must consist of full characters (i.e., a multiple of six bits). If a given field is signed, indicating an algebraic sort, the letter S is used. A logical sort on an unsigned field is denoted by U. Note that C and U need not be specified.

The following are examples of typical RECORD cards:

```

1 7
REC, FIELD/(8BS, 3BS, 2BS, 4BS) LEN/(500), TYPE/F
1 7
REC, TYP/V, LENGTH/(200, 1200, 800), FIELD/(8BS,
{ 4BS, 9BS, 2BS, }

```

SORT Card

The SORT card specifies the control fields used for sorting, the type of sort, and the nature of the collating sequence. One SORT card is required for each sort-and-merge or sort run.

The complete SORT card has the following format:

$$\left\{ \begin{array}{l} \text{SORT, FILE/n, ORDER/n, FIELDS/(n_1 \left[\left\{ \frac{A}{D} \right\} \right], \dots} \\ \text{, } n_1 \left[\left\{ \frac{A}{D} \right\} \right] \text{) } \left[\text{, SEQUENCE/ } \left\{ \frac{S}{C} \right\} \right] \end{array} \right.$$

The fields of the SORT card are defined as follows:

, FILE/n

The number n corresponds to the input number on the input FILE card and uniquely specifies the file to be sorted.

, ORDER/n

The number n specifies the order of merge (the number of merge tape units on each of the two channels to be used for merging). Note that n must be at least two and must not exceed eight.

$$, \text{FIELD}/(\mathfrak{n}_1 \left[\left\{ \frac{A}{D} \right\} \right], \dots, \mathfrak{n}_l \left[\left\{ \frac{A}{D} \right\} \right])$$

The **FIELD**S option specifies the control fields upon which sorting or merging is performed. The number **n₁** is the primary control field for sorting, **n₂** is the secondary control field, etc. Parameter **n** is the number corresponding to the position of the field-length parameter in the **FIELD** definer on the **RECORD** control card. The letter **D** indicates a descending sort and **A**, which need not be specified, indicates an ascending sort.

$$\left[, \text{SEQUENCE} / \left\{ \frac{S}{C} \right\} \right]$$

If specified, C indicates that the fields (n_1, \dots, n_i) are sorted according to the commercial collating sequence. If this parameter is omitted or if S is specified, the scientific sequence is used.

The following are examples of typical SORT cards:

1	7
SORT, FILE/62, SEQ/S, FIE/(3D), ORDER/2	
1	7
SOR, FIELD/(2D, 1), ORD/3, FIL/263	

MERGE Card

The MERGE card specifies control fields for merging. One MERGE card is required for each sort-and-merge or merge run.

The complete MERGE card has the following format:

$$\begin{array}{l} \overbrace{1 \quad 7} \\ \text{MERGE, FILES/ } (n_1, \dots, n_i), \text{ ORDER/n, FIELDS/} \\ \left\{ (n_1 \left[\left\{ \frac{A}{D} \right\} \right], \dots, n_i \left[\left\{ \frac{A}{D} \right\} \right]) \right. \\ \left. \left[\text{, SEQUENCE/ } \left\{ \frac{S}{C} \right\} \right] \right\} \end{array}$$

Most fields of the MERGE card are the same as those of the SORT card. During a sort-and-merge run, both the SORT and MERGE cards must be included. Each must specify its own FILES field. The other fields may be specified on either card but need not be put on both cards. The fields are defined as follows:

$$, \text{FILES}/(n_1, \dots, n_l)$$

Numbers n_1 through n_i correspond to the input number on the input FILE cards and uniquely specify the files to be merged.

ORDER/n

The number `n` specifies the order of merge (number of merge tape units on each of the two channels used for merging). For merging, `n` equals the number of files to be merged and must not be less than two nor more than eight. For a sort-and-merge run, the order must be at least one more than the number of external files to be merged with the Merge Phase output during the Final Merge Phase. A sequence check on a file may be performed by using a merge order of one and specifying only one file.

$$, \text{FIELDS}/(n_1 \left[\left\{ \frac{A}{D} \right\} \right], \dots, n_i \left[\left\{ \frac{A}{D} \right\} \right])$$

This field specifies the control field upon which merging is performed. Parameter n is a number corresponding to the position of the field-length parameter in the FIELD definer on the RECORD control card. The letter D indicates a descending merge and A, which need not be specified, indicates an ascending merge.

$$\left[, \text{SEQUENCE} / \left\{ \frac{S}{C} \right\} \right]$$

If specified, C indicates that the fields (n_1, \dots, n_i) are merged according to the commercial collating sequence. If this parameter is omitted or if S is specified, the scientific sequence is used.

The following is an example of a typical MERGE card:

```
1 7
MERGE, SEQ/S, ORD/4, FIELDS/ (1A),
FILES (4, 6, 3, 1)
```

CHANNELS Card

The functions of the CHANNELS card are:

1. To specify the channel on which to mount the input file during a sort or a straight merge run.
2. To indicate the channels used for merging.
3. To specify the output channel if desired.

The actual physical units to be used are determined through the IBSYS System Monitor and its Availability Table. One CHANNELS card is required for each run.

The complete CHANNELS card has the following format:

$$\begin{array}{c}
1 \quad 7 \\
\hline
\text{CHANNELS,} \\
\\
\left\{ \begin{array}{c} \text{INPUT/} \\ \left\{ \begin{array}{c} A [n] [R] \\ B [n] [R] \\ \vdots \\ H [n] [R] \\ J [n] [R] \\ \vdots \\ Q [n] [R] \\ UT [n] [R] \end{array} \right\} \end{array} \right\}, \text{MERGE/} \left(\begin{array}{c} \left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \end{array} \right\} \end{array} \right) \\
\\
\left\{ \begin{array}{c} \left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \end{array} \right\} \end{array} \right\} \left[\begin{array}{c} \vdots \\ UT [R] \end{array} \right] \left[\begin{array}{c} \text{OUTPUT/} \\ \left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \\ c \{n\}, c_1 \{n_1\} \end{array} \right\} \end{array} \right]
\end{array}$$

The fields of the CHANNELS card are defined as follows:

$$, \text{INPUT/} \left\{ \begin{array}{c} A [n] [R] \\ B [n] [R] \\ \vdots \\ H [n] [R] \\ J [n] [R] \\ \vdots \\ Q [n] [R] \\ UT [n] [R] \end{array} \right\}$$

This field designates the channel or units to be used for input. The following possibilities exist:

1. If one of the real channels (A through H) is specified, Sort assigns a unit to the input function from the availability chain for that channel. This is normally the first 729 or 7340 tape unit in the availability chain for the specified channel. However, if number *n* is specified, the *n*th units in the chain is assigned. Sort ignores devices other than 729 or 7340 tape units that may be in the chain. Normal practice calls for an input tape to be rewound and unloaded after sorting. Specifying the letter *R* causes the tape to be rewound only.

2. If an intersystem units on a symbolic channel (J through Q) is specified, the units containing the proper indication in its unit control block is assigned to the input function. If *n* is not indicated, blank is assumed. The tape is never unloaded. The letter *R* appearing after an intersystem unit designation causes the unit to be released from the intersystem reserve status when sorting is finished.

3. If the utility tape designation *UTn* is given, Sort assigns to the input function the unit to which the *UTn* function is attached. The number *n* must be any value from one to four.

4. If more than one parameter is specified for a straight merge run, and each indicates a unit on the same channel, each parameter is assigned to the input function. On a sort run, not more than two units may be assigned to the input function.

$$, \text{MERGE/} \left(\left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \end{array} \right\} , \left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \end{array} \right\} [, UT [R]] \right)$$

This field designates the channels on which merging takes place. The following possibilities exist:

1. For merging, two different real channels (selected from channels A-H) must be specified. Sort takes the required number of units from the availability chain of each channel.

2. Specifying the *UT* field causes the utility tapes to be assigned to the merge function if both

- a. The availability chain for a channel does not have enough units available for merging, and
- b. There is a utility tape on the channel which needs another merge tape.

Under the IBSYS System Monitor, these tapes are still attached as IBSYS utility tapes. If any one of these tapes is used as a Sort output reel, it should not be used by another system in a utility function until the sorted file is used or removed.

3. If *R* is specified, the tapes are rewound only.

$$\left[, \text{OUTPUT/} \left\{ \begin{array}{c} A [R] \\ B [R] \\ \vdots \\ H [R] \\ c \{n\}, c_1 \{n_1\} \end{array} \right\} \right]$$

The OUTPUT field designates the channel or unit on which the output is written. The following possibilities exist:

1. If this field is not specified, output is written on the unit on which it would normally occur. The number of this unit is

always printed on-line. Unless *R* is specified for the particular channel in the merge field, the tape is unloaded.

2. When one of the real channels (A-H) is indicated and this channel is one of the two used for merging, an extra pass in the Merge Phase may be necessary to place the output on the proper channel. The output is placed on the unit on which it would normally occur. If a third channel is specified for output, the extra pass is unnecessary. The output is placed on the first available unit in the availability chain for that channel which was not assigned to the input function. Letter *R* specifies that the tape is not to be unloaded.

3. As many as two intersystem reserve units may be specified for output use. The letters *c* and *c₁* may be any of the intersystem channels J through Q. The letters *n* and *n₁* may be any of the eleven characters zero through nine and the BCD blank. If either *n* or *n₁* is omitted, the BCD blank is assumed.

Under any of the following conditions, only one intersystem reserve unit will be available for output:

- a. If less than two intersystem reserve units are requested.
- b. If there is only one output reel.
- c. If the merge order is one.

If one or more intersystem reserve units are specified on the CHANNELS card, Sort prints the message:

UNIT XX IS INTERSYSTEM RESERVE UNIT YY
where:

XX is the absolute designation of the channel (e.g., A4)

YY is the symbolic designation of the channel (e.g., J1)

The bits specifying the channel and tape units are placed in the first unit control word of the particular unit control block, and the tape is rewound.

The following are examples of typical CHANNELS cards:

```

1 7
-----
CHAN, INP/A2R, MERGE/(AR, DR), OUT/ER

1 7
-----
CHANNELS, OUT/K2, INPUT/B3, MER/(A, D)

```

OPTION Card

The OPTION card specifies various available options. It is necessary to include an OPTION card only if one or more options are required.

The complete OPTION card has the following format:

```

1 7
-----
OPTION [, CKSUMS] [, NOCKPT] [, EQUALS]
      { [, UNRDBLK] [, RELCOM/n] [, BUFFER]
      { [, VARIABLE BLOCKING] [, MAP] [, HISTORY]
      { [, CARDS] [, TAPES] [, NOF]

```

The fields of the OPTION card are defined as follows:

[, CKSUMS]

If specified, a check sum is computed for each logical record in a sort run, retained for the entire run, and then dropped when the final output is written. Since a merge run involves only one pass, check sums are not useful; hence the option is ignored in such a run. In a combined sort-and-merge run, the files produced by the Internal Sort and Merge Phases must be of the same record format as those on the external merge tapes. Because check sums on the internal file tape would cause the formats to be different, this option is ignored in such a run.

[, CKSUMS]

When NOCKPT is specified, it indicates that no checkpoints are to be written during the Sort. Normal checkpoints are, therefore, deleted. If there is no tape attached as SYSCK2, the NOCKPT option is assumed. If no checkpoints are taken, restart is impossible except from the beginning of job (see "Checkpoint and Restart Procedure").

[, EQUALS]

When this option is specified, Sort adds a record-sequence word to each logical record to keep all records with equal control fields in the same order as they appear in the input file. Whether or not this option is specified, Sort never deletes records from a file solely because they are equal. Deletion of equal records can be accomplished through a modification by the user. The EQUALS option should not be used in a merge run or in a combined sort-and-merge run for the same reasons as given under CKSUMS.

[, UNRDBLK]

The UNRDBLK field is used if Sort is to be deleted when an unreadable record occurs. This option causes deletion of Sort if one of the following occurs:

- a. Either an offsize record block or a redundant record block is read by the Internal Sort Phase, Merge Phase, or Final Merge Phase.
- b. The check sum of a logical record is in error.

[, RELCOM/n]

For this field, n is the number of locations in upper core storage that Sort should leave above its COMMON area. To ensure adequate storage area for sorting, n should not exceed 10,000. Sort automatically leaves room for SPOUT, the IOEX off-line message writer, which occupies the 200 locations just under SYSEND.

[, BUFFER]

If specified, Sort reads fixed-length records into a buffer rather than using a "scatter-read" method. This option permits records to be modified before they are sorted. Specifying this option reduces the size of the Record Storage Area.

[, VARIABLE BLOCKING]

If this option is specified, Sort accepts short blocks of fixed-length records if the block lengths are multiples of the logical record length.

[, MAP]

When this option is specified, the load addresses of all sub-programs are printed on-line.

[, HISTORY]

This field specifies that messages and counts are printed on-line between phases and passes.

[, CARDS]

This field specifies that columns 7-72 of all control cards are printed on-line. The REMARK card is always printed whether or not this option is selected.

[, TAPES]

Specifying this option causes the on-line printing of tape assignments to show:

1. The input units, in the order in which the files on these units are read
2. The merge units, in their order of use, on which the Internal Sort Phase writes
3. The remaining merge units in their order of use
4. The output units, in their order of use, if the output channel is specified on the CHANNELS card
5. The checkpoint tape if attached.

For a merge-only run, the input and output units are listed in their order of use.

[, NOF]

This field specifies that no off-line messages are written on SYSOU1. If there is no SYSOU1 attached, the NOF option is assumed. If NOF is not specified, unreadable records and the information indicated by the MAP, CARDS, TAPES, and HISTORY options are always written on SYSOU1. If unreadable records cannot be written on SYSOU1, they are put on SYSCK2 if it is attached.

The following are examples of typical OPTION cards:

```
1 7
┌ OPTION, CKS, TAPES, MAP, HIS, EQU, NOF
1 7
┌ OPT, NOCKPT, CARDS, BUF, VAR BLOCK, REL/1000
```

LABEL Card

The LABEL card is used to specify nonstandard labels on the output file.

The complete LABEL card has the following format:

```
1 7
┌ LABEL, IDENT/nHxxx . . . xn
```

The field of the LABEL card is defined as follows:

, IDENT/nHxxx . . . x_n

The letter n represents a number not less than 18 nor more than 120 and is a multiple of 6. It indicates the number of characters, xxx . . . x_n, comprising the label that is written at the beginning of each final output reel. If the number of characters after the letter H is greater than n, the excess characters are truncated. If n is such that the string of characters would extend beyond column 72, a continuation card must be used even if the characters on it are all blank. Characters on the continuation card must begin in column 7 immediately following the X in column 6.

The following is an example of a typical LABEL card:

```
1 7
┌ LAB, IDENT/30H MACHINE ROOM PAYROLL
└ } ACCOUNTS
```

OVERFLOW Card

The OVERFLOW card causes skipping of tape records that were read and processed during a previous sort run which had overflowed. An OVERFLOW card should be included only if it is desired to skip tape records at the beginning of the input file.

The complete format for the OVERFLOW card is as follows:

```
1 7
┌ OVERFLOW, BLOCKS/n
```

The field of this card has the following definition:

, BLOCKS/n

In this field, n is a decimal number specifying the number of tape records on the current reel that have been processed. Labels, checkpoints, or dictionary records are not included. When the maximum number of logical records to be sorted exceeds the number that can be processed by Sort, an overflow condition occurs. If an overflow condition occurs, a message is printed explaining the situation and giving the number of tape records already sorted on the current input reel. Two options are given in case of overflow: the sort can be continued, but an unending merge may occur; the sort can be discontinued after the records that were read in before the overflow occurred have been sorted. In the latter case, the OVERFLOW control card

may be used in a subsequent run to skip all tape records that were read in before the overflow occurred and to restart the sort after that point in the input file. The output from this sort can then be merged with the output from the sort that overflowed, to produce the entire sorted file.

The following is an example of a typical OVERFLOW card:

```
1 7
/ OVER, BLO/6
```

DELETE Card

The DELETE card causes a field in each logical record to be compared with a given field and a record deleted if the fields are alike. One DELETE card must be included for each control field configuration on which a comparison is to be made. For example, to delete all records beginning with the character A, B, or C, three DELETE cards must be included.

The complete format for the DELETE card follows:

```
1 7
/ DELETE, FIELD/n, IDENT/n { O } xxx ... xn
                           { B }
                           { H }
```

The field definitions of the DELETE card are given below:

, FIELD/n

Number n is the field, defined as n_1 on the RECORD control card, on which comparison is based.

, IDENT/n { O }
 { B } xxx ... x_n
 { H }

For this field, n is the number of octal figures (O), binary bits (B), or alphanumeric characters (H) following the appropriate identifying letter. This information, expressed as xxx ... x_n, is compared to the indicated field on the RECORD card. If the information is found in the specified field of a record, that record is deleted from the sort. The field xxx ... x_n must cover the full length of the field described on the RECORD control card.

The following are examples of typical DELETE cards:

```
1 7
/ DEL, FIELD/6, IDENT/30452
```

```
1 7
/ DELETE, IDE/9B100101010, FIE/3
```

REMARK Card

Any number of REMARK cards may be included in a run. The format for this card is:

```
1 7
/ REMARK xxx ...
```

The field (xxx ...) of this card represents any desired message that is to be printed on-line. Columns 7-72 of this card are always printed, regardless of the CARDS specification on the OPTION card.

The following is an example of a typical REMARK card:

```
1 7
/ REMARK ACCOUNTS RECEIVABLE RUN
```

MODIFICATION Card

This card specifies subprograms which are provided by the user of Sort. One MODIFICATION card must be included for each user modification that is used during the run.

The complete format for the MODIFICATION card is:

```
1 7
/ MODIFICATION, PROGRAM/name, CELLS/n
  { [, LOCATION/SYSxxx]    [, FORMAT/ { B } ] }
                           { U }
```

The fields of this card have the following definitions:

, PROGRAM/name

To designate the modification subprogram, "name" must be one of the names for which modification exits have been provided in the Sort system.

, CELLS/n

Decimal integer n indicates the number of core-storage locations occupied by the modification program and its parameters. [, LOCATION/SYSxxx]

The parameter SYSxxx informs Sort on which of the SYSUNI units the modification program is located. If it is on SYSLB1, the field may be omitted. If the modification is on tape, it must be in relocatable column-binary card format. If the modification program is in the card reader, it must be in relocatable row-binary card format.

If more than one modification is to be used during a phase and several modifications reside on one tape, they must be arranged on that tape in ascending order (XSM04, XSM06, XSM10, etc.). The user must make certain that the tape is correctly positioned so that the requested program can be located. SYSUNI tapes will not be rewound and searched again.

[, FORMAT/ { B }]
 { U }

This field informs Sort whether the modification is blocked as one tape record or is in single card-image format. If the modification program is blocked, this field may be omitted. A blocked modification program must have the same format as the regular subprograms on the IBSYS system tape.

The following are examples of typical MODIFICATION cards:

```
1 7
/ MOD, PROGRAM/XSM04, CELLS/800, LOC/SYSUT3
```

```
1 7
/ MODIFICATION, FOR/U, CELLS/1000, PRO/XSM06
```

RESTART Card

The RESTART card is used to initialize a restart procedure (see "Checkpoint and Restart Procedure"). The format for the RESTART card is:

```
1 7
/ RESTART
```

END Card

The END card must be the last card in each control card deck. If Sort jobs are stacked, the END card is the only card separating the decks.

The complete format for the END card is:

```
1 7
END
```

Typical Control Card Decks

The following Sort control card deck may be used to sort a file of 14-word fixed-length records having 100 records to a block. Sorting is done on the first four characters of the third word of each record, using the scientific collating sequence.

```
1 7
END
OPTION, CKSUMS, NOCKPT, HISTORY, CARDS
CHANNELS, MERGE/(A,B), INPUT/A
SORT, FILE/1, SEQUENCE/S, ORDER/3, FIELD/2A
RECORD, TYPE/F, LENGTH/14, FIELDS/(12 CU, 4CU)
FILE, MODE/D, BLOCKSIZE/1400, OUTPUT, DENSITY/H
FILE, INPUT/1, REELS/1, MODE/D, DENSITY/H, BLOCKSIZE/1400
```

The same Sort run can also be accomplished by using the cards listed below:

```
1 7
END
OPT, CAR, NOC, HIS, CKS
CHA, INP/A, MER/(A, B)
SOR, ORD/3, FIE/2, FIL/1
REC, FIE/(12,4), LEN/14
FIL, OUT, BLO/1400
FIL, INP/1, BLO/1400
```

Chapter 4. Sort Subprograms and Communications

The IBM 7090/7094 Sorting System comprises the subprograms listed in Table II. They are listed in the order in which they appear on the distributed system tape, symbolic tape, and listing tape. The description of each subprogram is given with the phases during which it may be loaded. In this table, EP stands for Edit Phase, FXS for Internal Sort Phase with fixed-length records, VXS for Internal Sort Phase with variable-length records, XS for both types of Internal Sort Phase, MR for Merge Phase, and FM for Final Merge Phase. If Sort uses only 729 magnetic tapes for a given run, the subprograms marked (729) are loaded. If 7340 Hypertape Drives are used at any time during the run, the subprograms marked (7340 and/or 729) are loaded.

Table II: Sort Subprograms

NAME	SYMBOLIC CARD IDENTIFI- CATION	DESCRIPTION	PHASE(s) LOADED
Sort	ISM	Monitor and Loader	All
HYSTAR	ARS	Restart	EP, XS ¹ , MR ¹ , FM ¹
IOPEN	ASO	Open and Close (729)	XS, MR, FM
LABEL	BLB	Label	All
BTD	CBT	Binary to Decimal	All
CALC	CCA	Calculations	EP
EP001	CEP	Edit Phase	EP
RB01	CRB	Control Card Conversion	EP
RELEASE	CRE	Release Tapes	EP, FM
SK001	CSK	Scan Control Cards	EP
VXS	CVX	Variable Internal Sort	VXS
MERGIO	DBS	Merge I/O (729)	MR, FM
BUFRD	DBU	Buffer Read	FXS ¹
XTRACT	DEX	Extract Control Fields	XS, MR, FM
FXS	DFX	Fixed Internal Sort	FXS
GET	DGE	Buffer Read (729)	VXS
PUT	DPU	Scatter Write	VXS
READ	DRE	Scatter Read	FXS
WRITE	DWR	Scatter Write	FXS
WTFIX	DWT	Table Fixer	FXS
DEBLK	EDD	Deblock and Dump	XS, MR, FM
FIMRG	EVF	Final Merge Phase (729)	FM
MERGE	EVM	Merge Phase (729)	MR
POSTP	FPP	Postprocessor	FM
CKPT	GCK	Checkpoint Writer	XS ¹ , MR ¹ , FM ¹
DELETE	GDE	Delete	XS ¹ , FM ¹
HYFIMR	HFM	Final Merge Phase (7340 and/or 729)	FM
MRGHYO	HIO	Merge I/O (7340 and/or 729)	MR, FM

Table II: Sort Subprograms (Cont.)

NAME	SYMBOLIC CARD IDENTIFI- CATION	DESCRIPTION	PHASE(s) LOADED
HYMERG	HMR	Merge Phase (7340 and/or 729)	MR
HYOPEN	HOP	Open and Close (7340 and/or 729)	All
HYGET	HYG	Buffer Read (7340 and/or 729)	VXS

¹ Optional

Programs Loaded in Each Phase

In Figure 3, the symbols T1-T6 indicate the time sequence of the various stages of Sort. In a straight merge run, T4 and T5 are omitted. The symbols are explained in the following text:

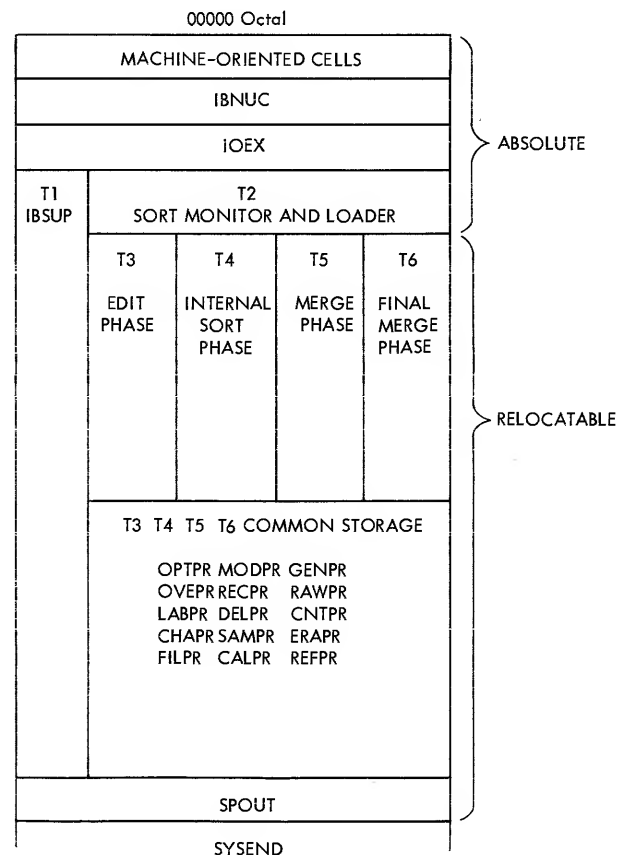


Figure 3. Core Storage Layout for 7090/7094 Sort System

T1—Calling of 7090/7094 Sort

Sort is called by the IBSYS System Monitor by a

1	16
\$EXECUTE	SORT

control card (see “IBSYS System Monitor Control Cards”). IBSYS defines the machine configuration and provides the necessary information on the availability of input/output units.

T2—Loading of Sort Monitor

IBSYS loads the Sort Monitor. At this point, control passes to the Sort Monitor. The Sort Monitor includes the Sort Subprogram Binary (SSB) Loader, which loads the subprograms required for each phase.

T3—Loading and Execution of Edit Phase

At the beginning of execution of Edit Phase, the control cards are read from SYSIN1, the symbolic designation of the IBSYS input function. They are analyzed to determine if a sort and/or merge run is to be performed or if control is to be returned to IBSYS. The subprograms loaded in this phase are:

HYSTAR	RB01
LABEL	RELEAS
BTD	SK001
CALC	HYOPEN
EP001 (M)	

(M) Main subprogram of the phase

T4—Loading and Execution of Internal Sort Phase

The Internal Sort Phase subprograms for the internal sort of either fixed-length or variable-length records are loaded to overlay the Edit Phase. The subprograms loaded in this phase are:

FOR FIXED-LENGTH RECORDS	FOR VARIABLE-LENGTH RECORDS
HYSTAR ¹	HYSTAR ¹
IOPEN or HYOPEN	IOPEN or HYOPEN
LABEL	LABEL
BTD	BTD
XTRACT	VXS (M)
FXS (M)	XTRACT
READ or BUFRD	GET or HYGET
WRITE	PUT
WTFIX ²	DEBLK
DEBLK	CKPT ¹
CKPT ¹	DELETE
DELETE ¹	

¹ Optional

² Loaded only if READ is loaded

(M) Main subprogram of the phase

T5—Loading and Execution of Merge Phase

The Merge Phase subprograms, if needed, are loaded to overlay the Internal Sort Phase. The subprograms loaded in this phase are:

HYSTAR ¹
IOPEN or HYOPEN
LABEL
BTD
MRGIO or MRGHYO

XTRACT
DEBLK
MERGE or HYMERG (M)
CKPT ¹

¹ Optional

(M) Main subprogram of the phase

T6—Loading and Execution of Final Merge Phase

The Final Merge subprograms are loaded to overlay the Merge Phase. The subprograms loaded in this phase are:

HYSTAR ¹	XTRACT
IOPEN or HYOPEN	DEBLK
LABEL	FIMRG or HYFIMR (M)
BTD	POSTP
RELEAS	CKPT ¹ or HYCKPT ¹
MRGIO or MRGHYO	DELETE ¹

¹ Optional

(M) Main subprogram of the phase

After the Sort run has been completed, the Post-processor subprogram of the Final Merge Phase is executed. This subprogram releases all tape assignments and prints counts of records sorted, records deleted, records dumped, padding records added, and reserve units used for intersystem communication. It then returns control to the Sort Monitor, which in turn returns control to the T3 stage of Sort.

System Tape

The IBSYS system tape contains in two adjacent files all the subprograms which comprise the Sort system. The first file contains one subprogram, named SORT, which contains the Sort Monitor and Loader. The second file contains several subprograms, each assembled in relocatable form and consisting of one tape record formed by blocking the column-binary card images for the subprogram. References to “card” signify a card image on the IBSYS system tape.

The subprograms that are to be loaded by the Sort Loader are placed on the IBSYS system tape in the following manner:

Loading Format and Name of First Subprogram
Program Card
Program
Transfer Card
Interrecord Gap
Loading Format and Name of Second Subprogram
Program Card
Program
Transfer Card
Interrecord Gap
:
:
Interrecord Gap
Loading Format and Name of Last Subprogram
Program Card
Program
Transfer Card
End-of-File Tape Mark

The entries in the preceding list are described as follows:

Loading Format and Name: The first three cards in the blocked subprogram tape record must have the following format:

IOCP	45000 , , 1
BCI	1 , (name of subprogram)
IOCP	45002 , , n

where n is the number of words in the program following the second IOCP. The information supplied by these cards is used for program recognition and for loading whenever the Sort Loader is not used (e.g., when loading from a unit other than a tape unit or when editing an IBSYS system tape).

Program Card: The program card, prepared by IBSFAP, contains the entry names used in the subprogram, the length of the subprogram, the length of the transfer vector, and the COMMON break (i.e., the highest core-storage location before COMMON storage). Ten is the maximum number of entry names that may be used in any Sort subprogram or user's modification subroutine.

Program: The program must be assembled in relocatable binary form using IBSFAP.

Transfer Card: The Sort Loader recognizes the end of a subprogram when it reads a transfer card. The transfer card may have either of the following formats, both of which have the same effect on the Loader:

1. 12-punch, 7-punch, and 9-punch in column one
2. 11-punch, 7-punch, and 9-punch in column one

When an IBSYS system tape is assembled by IBEDT and relocatable subprograms are either inserted or replaced from the punch tape prepared by IBSFAP, all required cards are provided by IBEDT.

Sort Subprogram Binary Loader

The subprograms necessary for each phase of Sort are loaded by the Sort Subprogram Binary (SSB) Loader prior to the initiation of the phase. Thus, storage is not taken up by subprograms used by another phase, and

the number of core-storage locations used by subprograms is kept to a minimum for each phase.

In loading subprograms, the SSB Loader performs the following operations:

1. It clears core storage between its own location and that of COMMON storage location.
2. It reads a subprogram into core storage beginning at octal location 45000.
3. It determines whether that subprogram is needed for the particular phase of Sort involved.
4. If this subprogram is needed, it is relocated as far down in core storage (toward SYSORG) as possible so that it follows directly after the last subprogram that was loaded.

5. Operations 2, 3, and 4 are repeated until all subprograms needed for the given phase are loaded.

The SSB Loader must know the number of subprograms to be loaded during each phase, the names of these subprograms, and the input devices on which these programs are located. This information is supplied to the Loader by a calling sequence, which is constructed during Edit Phase by the Calculations subprogram. All subprograms except modification subroutines must be on the system tape. The modification subroutines may be located in the card reader (SYSCRD), on any SYSUNI tape, or on the IBSYS system tape.

While loading each phase, the SSB Loader builds a list of names of subprograms that have been loaded. The list also specifies where the subprograms are loaded and indicates the number of transfer vectors associated with each subprogram. After loading has been completed, each entry in the transfer vector of each subprogram is replaced by a transfer to the load address of the called subprogram (i.e., by a TTR *****) if the subprogram has been loaded. If the subprogram has not been loaded, a store-location-and-trap instruction (STR 0,0,0) replaces the transfer vector. If a subprogram that was not loaded is called, the STR instruction causes an IBSYS core-storage dump to be taken. This Sort run is then deleted and additional Sort runs are deleted until a \$JOB card is processed by IBSYS.

Chapter 5. File Structure

Input to Sort consists of files of either fixed-length or variable-length logical records, written in either binary or decimal mode. The maximum length of a tape record is 2,000 words, not including the check-sum block-sequence word, that can be appended to a tape record if the file is written in binary mode. The minimum length of a tape record is three words, in keeping with tape error recovery conventions employed by IOEX, the input/output executor of the IBSYS System Monitor.

Table III specifies the density and mode conventions of header labels, dictionaries, checkpoints (which may appear only on input files), data, trailer labels, and the end-of-file (EOF) marks associated with all of them. Sort expects these conventions to be used when input for a sort and/or merge run is created. All output from Sort is governed by these same conventions.

Table III: Density and Mode Conventions

RECORD	MODE	DENSITY	REMARKS
Header Label and EOF	Decimal	High or low	Label and EOF must have same density. However, density and mode of label and EOF may differ from that of data.
Dictionaries and EOF	Decimal	High or low	If a file is labeled, dictionary must have same density as label. If a file is unlabeled, density and mode of dictionary may differ from that of data. Dictionary and EOF must have same density.
Checkpoint and EOF	Binary	High or low	Checkpoint and EOF must have same density as data.
Data Blocks and EOF	Binary or Decimal	High or low	Data and EOF must have same density.
Trailer Label and EOF	Decimal	High or low	Label and EOF must have same density as data.

Labels

A label is a one-record tape file that identifies a data file or part of a data file. Labels occur at the beginning and at the end of a file. The first label of each segment is the header label, and the last label is the trailer label. Standard labels contain the name of the file, the length of time the file is to be retained, the date on which the file was created, and information concerning the characteristics of the data file.

Labels may be used to identify segments of a file. For example, if a file is contained on five reels of tape, the header labels indicate the order in which the reels should be read, and the trailer label on each reel indicates whether or not the file has come to an end. Each reel before the last reel has an end-of-reel trailer label. The last reel ends with an end-of-file trailer label.

Sort handles either of two types of standard labels. These are the 7090/7094 iocs label described in the publication *IBM 7090/7094 IBSYS Operating System, Input/Output Control System*, Form C28-6345, and the IBM standard tape label described in the publication *IBM Standard Tape Label*, Form C28-8142.

If the input FILE card specifies that the input file has a standard label, the label is read and checked. If the input is on 729 magnetic tape, the label may be either the 14-word iocs label or the 20-word IBM standard label. If the input is on 7340 Hypertape, the label must be the 20-word IBM standard label.

If the output FILE card requests a standard label on the output file, the label is the 20-word IBM standard label if the output is on 7340 Hypertape. If the output is on 729 magnetic tape, the 14-word iocs label is written unless the input file contains the 20-word IBM standard label. In this case, the 20-word IBM standard label is written on the output file.

If the input file contains a nonstandard label, the label is read if so specified on the input FILE card. It is not checked. Nonstandard labels may be up to 20 words long and are truncated if they exceed this limit.

A nonstandard label is put on the output file by specifying it on the output FILE card. If a LABEL control card is present, the output label contains the information found on that control card. If there is no LABEL card, the nonstandard output label is the label (standard or nonstandard) read from the input file.

Dictionary

If a 9PAC Dictionary is present, it is in the first file on the tape. It may be the only information in this file, or it may share the file with the label. In the latter case, its position is between the label and the end-of-file mark. Dictionary records are 14-word BCD tape records (see the publication *IBM 7090 Programming Systems: SHARE 7090 9PAC Part 1: Introduction and General Principles*, Form J28-6166). There is no limit to the number of dictionary records. During the Sort, the

records are saved on SYSCK2 and are then transferred to the final output file. If no SYSCK2 tape is attached, the dictionary records are deleted.

Tape Record Format

The number of data words in a tape block, which comprises one or more logical records, must be at least 3 and not more than 2,000. In a binary file, an extra word may be added to each block. This word, containing a block check-sum block-sequence number, is not considered in the block size or in the 2,000-word maximum size (see "Input and Output FILE Cards").

Fixed-Length Block Format

The block size specified on the input FILE card must equal the number of data words in an input block unless the VARIABLE BLOCKING option is specified on the OPTION card. In this case, the number of data words may be fewer than the block size given, but it must be a multiple of the input logical record length. An output block contains the number of data words specified by the block size on the output FILE card. Unless padding is specified, the last output block may be smaller than the block size if there are not enough records to fill the block.

Variable-Length Block Format

The block size specified on the input FILE card must be at least equal to the number of data words in the largest input block. An output block contains no more data words than the block size number specified on the output FILE card unless there is a logical record having more data words than this number. In this case, the larger logical record is written in a block by itself.

Logical Record Format

Fixed-Length Records

Fixed-length input records may be in either binary or decimal mode, and one or more records may be blocked to form a tape record. As with a tape record block, maximum size of a logical record is 2,000 words. Minimum logical record size may be one word, but a tape record must contain at least three words.

Variable-Length Records

Variable-length input records may be in either binary or decimal mode, and one or more records may be blocked to form a tape record. Maximum size of a variable-length record is 2,000 words, including the record control word.

The two modes are described as follows:

Binary Mode: The first word of binary logical records is a record control word whose decrement contains the number of data words in the record following this control word. The format for this word is:

IOCTN ** , , n

Sort uses only the decrement of this word.

Variable-length records in binary mode must contain the record control word and at least two data words unless the check-sum and/or block-sequence option(s) is taken. If either of these options is chosen, the minimum three-word tape record length is assured even if the data consists of only one word.

Decimal Mode: The first word of BCD logical records is a record control word containing the number of characters in the entire record, including the control word and data words. This number is expressed as five BCD characters right-justified in the first five characters of the word. The sixth character may be any valid BCD character.

Examples

00036C

00108E

The record length must be at least 18 characters and must be a multiple of 6.

When the input record is in BCD and the requested output is binary, the record control word on the output tape is expressed in the form

IOCTN** , , n

If a variable-length record not within the range of lengths specified on the RECORD control card is read in the Internal Sort Phase, Sort cannot continue. An error message is printed, followed by a pause during which a core storage dump may be taken.

In the Final Merge Phase, variable-length records read from an external merge tape during either a merge or a sort-and-merge run are checked to determine if the block length equals the sum of the lengths of the records in the block.

Internal Record and Block Format

All tapes prepared by the Internal Sort and Merge Phases are written in the binary mode. The number of records per block on these tapes may differ from the number of records in an input or output block.

Two words are added at the beginning and one at the end of each merge block. These words contain the following merging information:

1. The block-sequence number in the address of the first word
2. The string count in the decrement of the second word

3. The number of records per block in the address of the second word

4. The block length in the decrement of the word at the end of the block

The first half of the first word and the last half of the last word contain special bit structures to detect character shifting by the merge tape unit.

If either the CKSUMS or EQUALS option or if both options are specified on the OPTION control card, the logical record length is automatically enlarged during the Merge Phase to accommodate the extra word which is added to each record for each option. These extra words are dropped during the Final Merge Phase.

Control Field Format

The control fields of a record may be expressed in either bits or characters. If control fields are to be sorted in accordance with the commercial collating sequence and the control fields are expressed in bits, the number of bits specified must be a multiple of 6.

It is possible to mix, in the same record, control fields to be sorted in ascending sequence with fields to be sorted in descending sequence. The maximum number of control fields which may be defined in a logical record has been effectively set at 200. If necessary, this number can be increased in the Edit Phase by changing BES 200 to BES xxx (where xxx is the number of control fields desired) at the following symbolic locations:

FIELN	FILLB
FIEUS	FILNW
FILSW	FILLM
FILSB	FILRM

Control Field Information

Each control field used to sort or merge records has a 9-word block of information in storage. This informa-

tion is developed during the Edit Phase from the parameters on the SORT (or MERGE, in a merge run) control card. The contents of each word are given below.

WORD	BITS	CONTENTS
1	3-17	Numbers of words over which the control field extends
	18-20	0 - logical ascending 1 - logical descending 2 - algebraic ascending 3 - algebraic descending 4 - signed BCD ascending 5 - signed BCD descending
	21-35	Number of the word in the logical record that contains the last bit of the control field
2		RQL **
3		LGL **
4		LGL **
5		LGL **
6		LGL **
7		LGL **
8		LGL **
9		LGL **

The control field information facilitates extraction of the associated control field. In a sort or merge run, all of the control fields are extracted and placed in front of the record. The RQL and LGL instructions needed in the extraction subprogram (XTRACT) are initialized by the Edit Phase.

Each DELETE control field also has a corresponding storage block of at least four words, as follows:

WORD	BITS	CONTENTS
1	3-17	Number of words over which the control field extends
	21-35	Starting word of control field
2		Left mask of first word
3		Right mask of last word
4-n		Information to compare with DELETE control field.

Both of the above information blocks are built from high core-storage toward low core-storage locations.

Chapter 6. Modifications by the User

Facilities are provided to allow the user to insert his own subroutines into the Sort system at load time. These subroutines can be entered and executed at specified points in the Sort system.

Modification subroutines are requested by using the MODIFICATION control card. One control card must be used for each modification subroutine desired during a run. The use of a MODIFICATION card sets a switch in COMMON to signify that a modification subroutine should be entered and executed. Tests for checking the status of these switches and transfers to modification subroutines are included at the locations in Sort where modifications are most desired. Each modification subroutine is loaded during the phase in which it is to be used.

As with other Sort subprograms, `IBSFAP` must be used to assemble the modification subroutines in relocatable form. Modification subroutine names are restricted to those for which exits from Sort have been provided. Names of modification subroutines used during Internal Sort Phase begin with the letters `xsm`; during the Merge Phase, with `mpm`; and during Final Merge Phase, with `fmm`.

If an installation performs many types of Sort runs, it is sometimes desirable that one modification switch be used for several subroutines, each of which is unique to the type of Sort run being performed. For example, it is possible to specify the following on the MODIFICATION card:

PROGRAM/XSM04C

where C is any valid bcd character. This permits loading of a particular subroutine, depending on the type of run.

Example

Suppose that in run one, the modification subroutine FMM04 is different from the modification subroutine to be used at the same place during run two. The MODIFICATION control cards for run one and run two might be as follows:

1 7
MODIFICATION, PRO/FMM04A, CELLS/20,
LOC/SYSUT3, FOR/B

and

1 7
MOD, PROGRAM/FMM04Z, CEL/50,
LOCATION/SYSUT3, FORMAT/B

Programs FMM04A and FMM04Z would be loaded during runs one and two, respectively.

A modification subroutine may obtain parameters from COMMON storage if COMMON has been defined in the subroutine as it is in each of the Sort subprograms. Modification subroutines may communicate with each other, or with any of the Sort subprograms, through transfer vectors or through COMMON. Each modification subroutine must save and restore any registers (e.g., AC, MQ, index registers, or sense indicators) which it uses.

After a modification subprogram has been assembled, if `IBEDT` places it in the second file of `Sort` on the `IBSYS` system tape, the correct format is provided by `IBEDT`. However, if the modification subroutine is to be read from the card reader or from a `SYSUNI` tape other than the `IBSYS` system unit, the transfer card must be provided by the programmer. An easy way to do this is by using the following sequence:

```

1      7      16
      *FAP
      FUL
      OCT      400500000000 (or 200500000000)
      END

```

The assembly of this sequence, which immediately follows the assembly of the subroutine, places a card on the punch tape after the cards of the subroutine. This card has the proper bits so that it is recognized by Sort as a transfer card.

Modification Exits

In the following discussion of modification exits, the exits associated with the Internal Sort Phase are given first. Following these is a Merge Phase exit, and then the Final Merge Phase exits.

For each exit, the exit name is given first. Then the logical condition of the Sort run at the point where the exit is utilized is indicated. Following this, the possible uses of the exit are listed.

Information related to the run during its different phases is often contained in areas (i.e., `ERAPR`, `CALPR`, etc.) within `COMMON` storage. The contents of the words in these areas, identified by a number following the area name, is listed for each phase of the run in the section "Allocation of `COMMON` Storage." In describing the exits, the locations of information that may be required for a particular subroutine are given.

The general procedures for typical uses of the exit are then described. The returns used after the sub-

routine are identified, and a flow chart showing the main steps of Sort associated with the exit is provided.

Exit XSM04 (Fixed-Length Record Run)

Logical Condition at This Point: A group of sorted records is ready to be written onto a merge tape by the Internal Sort Phase.

Possible Uses of XSM04: The xsm04 exit may be used:

1. To summarize records
2. To delete records
3. To alter records
4. To lengthen or shorten records

Parameter Locations: Key parameters at this point are located at:

ERAPR-27, which contains in its address the location of a table of tags. Each of these tags points to one of the records to be written. The decrement of ERAPR-27 gives the length of this table (the number of tags).

ERAPR-26, which contains in its address the location of a group of tags. Each of these tags points to a bin not currently being used. The decrement of the word at ERAPR-26 gives the length of the group.

ERAPR-1, which contains in its address the location of a table of tags. Each of these tags point to one of the records currently being processed by the Internal Sort Phase. The decrement of ERAPR-1 gives the length of this table. The table whose location is given at ERAPR-27 is part of the table whose location is given by ERAPR-1, and it precedes the table whose location is given in ERAPR-26.

ERAPR-3, which indicates the number of unused bins, not including those whose locations and lengths are given in ERAPR-26, at the time the modification subroutine is entered. The table of tags pointing to these unused bins follows the table whose location is given at ERAPR-1.

The tables whose locations are given at ERAPR-1, ERAPR-3, and ERAPR-26 are contiguous. The table whose location is given at ERAPR-1 is nearer SYSORG. It is followed by the table whose length is given in ERAPR-3 and then by the table whose location is given in ERAPR-26. The sum of the decrements of ERAPR-1 and ERAPR-26 plus the address of ERAPR-3 must always equal the address of CALPR-5.

ERAPR-15 must be initialized by the modification program to indicate the number of records originally specified in ERAPR-27 that the modification program has determined are not to be written from Internal Sort Phase. These records are not written because they have been either summarized into another record or deleted. Just prior to returning to Sort, the sum of the address portion of ERAPR-15 and the decrement of ERAPR-27 must equal the number that was in the decrement of ERAPR-27 at the time the modification program was entered.

Procedures: To summarize records, the following operations are performed by the modification program.

1. The composite (summarized) record is put in the bin of one of the component records.
2. If the check-sum option is specified, the check sum of the record is recomputed and placed in the last word of the bin.
3. Tags indicating unused bins are moved to the bottom (toward SYSEND) of the tag table whose location is given in word ERAPR-1 and whose length is given in CALPR-5.

4. The tags between the bottom of the table and those being moved down are moved up to fill the intervening locations, providing space for those being moved down.

5. The length of the tag table of records to be written, which is given in the decrement of ERAPR-27, is decreased, and the tag table whose location is given in ERAPR-26 is updated (decremented) by the same amount.

6. ERAPR-15 is initialized by the same amount used in operation 5.

7. ERAPR-3 is increased by the same amount used in operation 5.

To delete records, the preceding procedure must be followed, beginning with operation 3.

To alter a record, the modification program must recompute the check sum if the CKSUMS option is specified on the OPTION card.

To lengthen or shorten a record, the modification program must put the new logical record in the first part of the bin currently occupied by the record being modified. Sort has made the length of this bin long enough to accommodate both a record as large as specified by the parameters associated with the LENGTH definer on the RECORD control card and the equals and/or check-sum words if they are specified. The last two words are put into the bin by the modification program so that they immediately follow the modified record. If necessary, the modification program must recompute the check sum.

For each use of this exit, the return is to 1, 4.

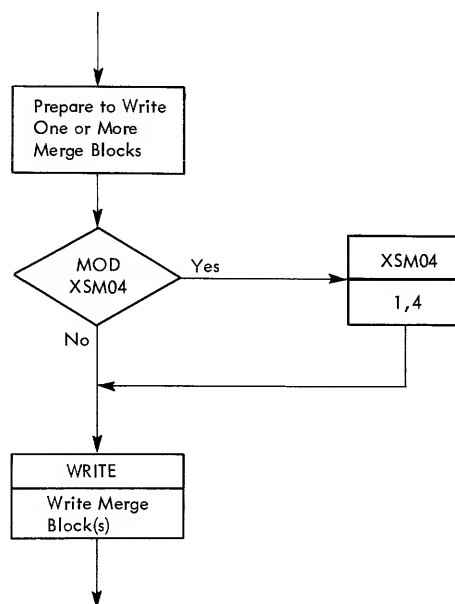


Figure 4. Exit XSM04 (Fixed-Length Record Run)

Exit XSM04 (Variable-Length Record Run)

Logical Condition at This Point: A group of sorted records are ready to be written onto a merge tape by the Internal Sort Phase.

Possible Uses of XSM04: The xsm04 exit may be used:

1. To summarize records
2. To delete records
3. To alter records

Parameter Locations: Key parameters at this point are located at:

ERAPR-10, which contains in its address the location of a table used as a calling sequence to the write subprogram, PUT. The decrement of ERAPR-10 contains the length of this table. Each entry in this table causes the writing of one tape record consisting of sorted records from the Internal Sort Phase. The address of each entry in this table points to a list of tags. Each of these tags points to the beginning of one logical record. The decrement of each entry in the table specified by ERAPR-10 indicates the length of the tag list giving the number of records to be written in the tape record.

ERAPR-17, which contains the number of words (in these records) that are to be written.

ERAPR-4, which contains in its address the location of the Availability Table, following which the write subprogram (PUT) builds the Write Table. The decrement of ERAPR-4 gives the current length of the Availability Table. The address portions of the words in the Availability Table indicate bins into which records may be moved.

Procedures: To summarize records, the modification program must put the composite record in the bins currently used by one of the records being summarized. The locations of the bins from which records are not to be written must be added to the Availability Table whose location is given in ERAPR-4. The length of this table must be updated. Tags (or pointers) indicating the beginnings of records which are not to be written out are not now required in the tables (or tag lists) specified by the entries in the table indicated by ERAPR-10. Each of these tables must be closed up. They need not be contiguous, however, provided the entries indicated by ERAPR-10 contain the correct locations and lengths of the tables. If the summarized record is not exactly the same length as the record it is replacing, the decrement of the last pointer (either the pointer to the first bin if the record is contained in one bin, or the pointer at the end of the next to the last bin) must be updated to reflect the exact number of words which are to be written from the bin to which it points. The pointers to the first bins of each logical record do not indicate the beginning of the bins, but rather the first word which is to be written on the merge tapes. The difference (number of words) between the beginning of the bin and the word indicated by the pointer is the number of words into which the control fields are extracted. This number is given by CALPR-12.

The process of deleting a record is similar to that of summarizing. The modification program must: put the

locations of the bins not being used into the Availability Table indicated by ERAPR-4; close up the tags specifying the records that are to be written; and update the table indicated by ERAPR-10.

To alter a record, the decrements of the tag locations indicating the continuation bins must indicate the exact number of words to be written from the next bin. Pointers to the continuation bins must point to the very first word of the bins. The number of words written from a continuation bin may be less than the capacity of a bin, but these words must be in adjacent words at the beginning of the bin.

For each use of this exit, the return is to 1, 4.

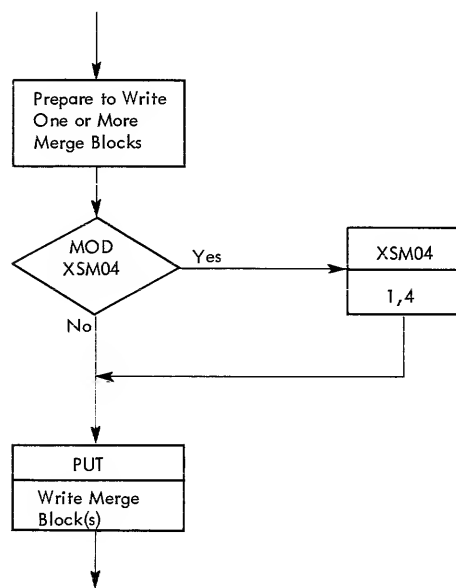


Figure 5. Exit XSM04 (Variable-Length Record Run)

Exit XSM06 (Fixed-Length Record Run with BUFFER Option)

If the BUFFER option is not specified, the xsm06 exit is not provided.

Logical Condition at This Point: A logical record is ready to be moved from the input buffer to a bin by the subprogram BUFRRD (Buffer Reading Routine).

Possible Uses of XSM06: The xsm06 exit may be used:

1. To keep a record from being deleted
2. To insert or replace a record
3. To delete a record

Parameter Locations: Key parameters at this point are located at:

ERAPR-4, which contains the location of the first word of the logical record which is ready to be moved from the buffer.

ERAPR-5, which specifies the location of the bin to be used during the next move.

RECPR-0, which gives the length of the logical record in the buffer.

CNTPR-14, which contains the total number of logical records which either have been moved from the buffer to bins or

have been deleted by the DELETE subprogram (or have been inserted by previously calling the modification program to insert a record).

Index register 1, which gives the number of logical records which remain to be moved to bins to complete the current read request. This number is the total number of records requested, M (see CALPR-6), minus the number already moved during this call to BUFRD.

Procedures: The normal return (i.e., with no records added or deleted) is to 1, 4. The record is then checked for deletion if the DELETE option is specified. To prevent this record from being checked for deletion when the DELETE option has been specified, the return should be to 2, 4.

To insert a record, the location of the bin to use is given in the address portion of ERAPR-5. The modification program must move the record into this bin. The return is to 3, 4.

To replace a record, the location of the bin to use is also given in the address portion of ERAPR-5. If the record is lengthened or shortened, it must be moved to

the bin by the modification program. The location of the record in the buffer (given by ERAPR-4) must be updated to indicate the next logical record in the buffer. This is done by adding the address portion of RECPR-0 to ERAPR-4, as shown by the following sequence:

CAL	ERAPR-4
ADD	RECPR-0
STA	ERAPR-4

The return is to 3, 4.

To delete a record, return to 4, 4. BUFRD then prepares to move the next logical record into the same bin.

Exit XSM06 (Variable-Length Record Run)

Logical Condition at This Point: A logical record is about to be moved from the input buffer to a bin by the subprogram GET (Sort input routine for variable-length records).

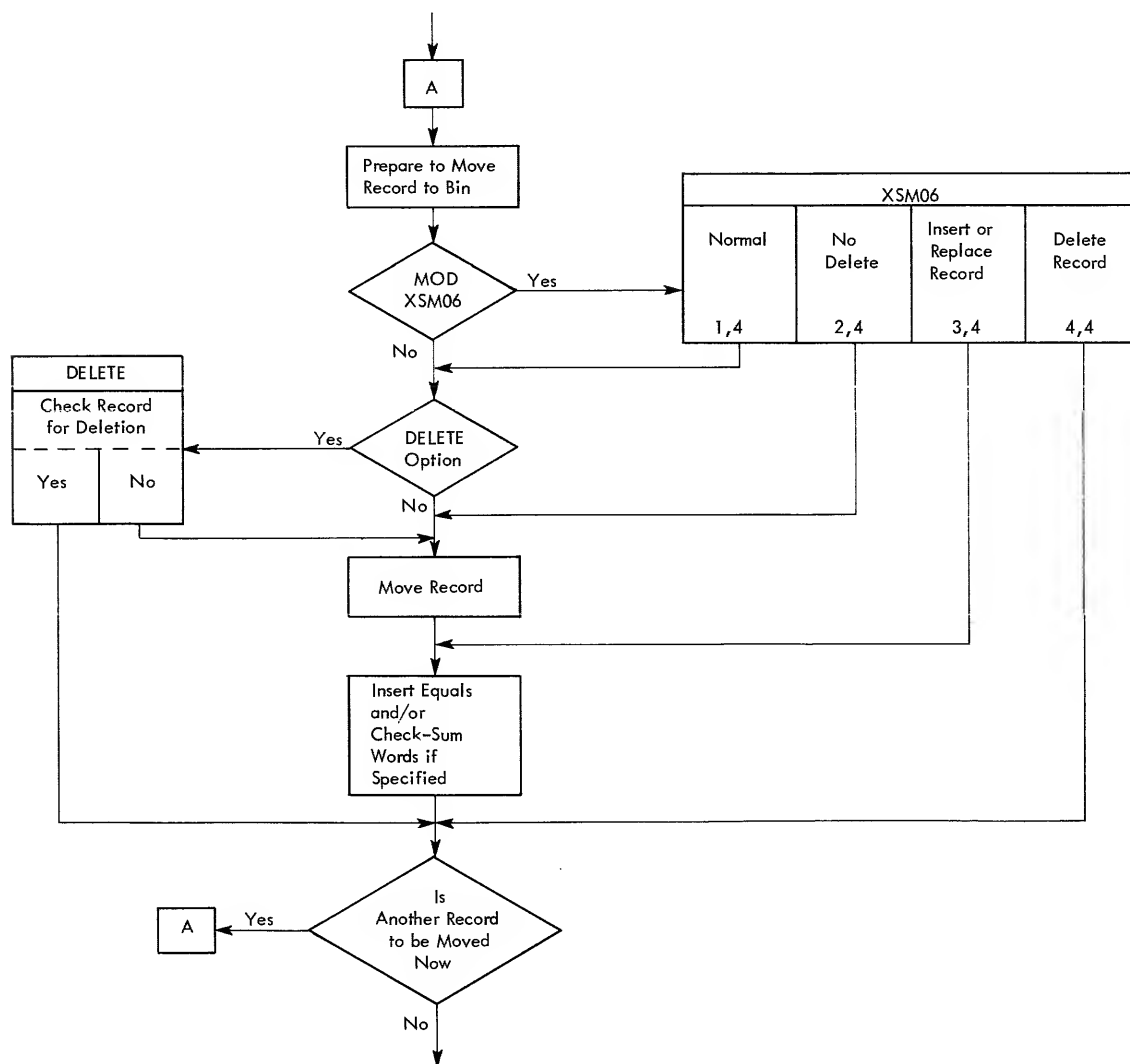


Figure 6. Exit XSM06 (Fixed-Length Record Run)

Possible Uses of XSM06: The xsm06 exit may be used:

1. To insert or replace a record
2. To delete a record

Parameter Locations: Key parameters at this point are located at:

ERAPR-23, which contains the location of the word in the input buffer immediately preceding the first word (i.e., the record control word which contains the length of the record) of the logical record that is to be moved from the buffer.

ERAPR-25, which indicates the length (word count) of the current record. The word count, which includes the record control word, is expressed in binary form and is in the address portion of ERAPR-25.

ERAPR-21, which contains the location of the word preceding the Current Availability Table. Bins are utilized beginning at the bottom of the table (toward SYSEND). Therefore, ERAPR-21 is essentially the base of the Availability Table. Bit 20 of this location represents index register 1 and is a 1 (representing the on condition).

ERAPR-22, which contains the 2's complement (negative) of the number of bins currently in the Availability Table. (The instruction

LAC ERAPR-22, T

puts the actual number in index register T.) The next bin location is easily determined by using the sequence

LXA ERAPR-22, 1
CLA* ERAPR-21

When a record is to be inserted or replaced, location ERAPR-22 must be examined to determine whether enough bins are available to contain the record. If there are enough bins, the word at location ERAPR-22 must be updated by adding the actual number of bins used for the record.

ERAPR-24, which contains the sequence number for the EQUALS option. If a record is inserted or replaced in a run which uses the EQUALS option, the contents of word ERAPR-24 must be incremented by 1. The new value is put into the proper word in the first bin that the record occupies.

CALPR-12, which indicates the number of core-storage locations that must be left at the beginning of the first bin of the record in order to contain the extracted control fields. In runs which specify the EQUALS option, the equals word (sequence number) is put in the first location following the extracted control fields. If the CKSUM option is specified, the check sum is placed either in the location following the equals word if the EQUALS option is specified, or following the extracted control fields if the EQUALS option is not specified. The actual record follows the check-sum location. The record control word, which contains the length of the record, is the first word of the record. If neither the EQUALS nor the CKSUMS option is specified, the record control word follows the extracted control field area.

CALPR-3, which contains the length of each bin. The first bin must contain: the extracted control fields; the equals word if specified; the check sum if specified; the first part of the logical record, including all control fields; and a word indicating where the record is continued. Whenever a record spills over into another bin, the last word of the previous bin must be initialized to indicate the next bin. The address portion of the last word contains the location of the next bin, the decrement

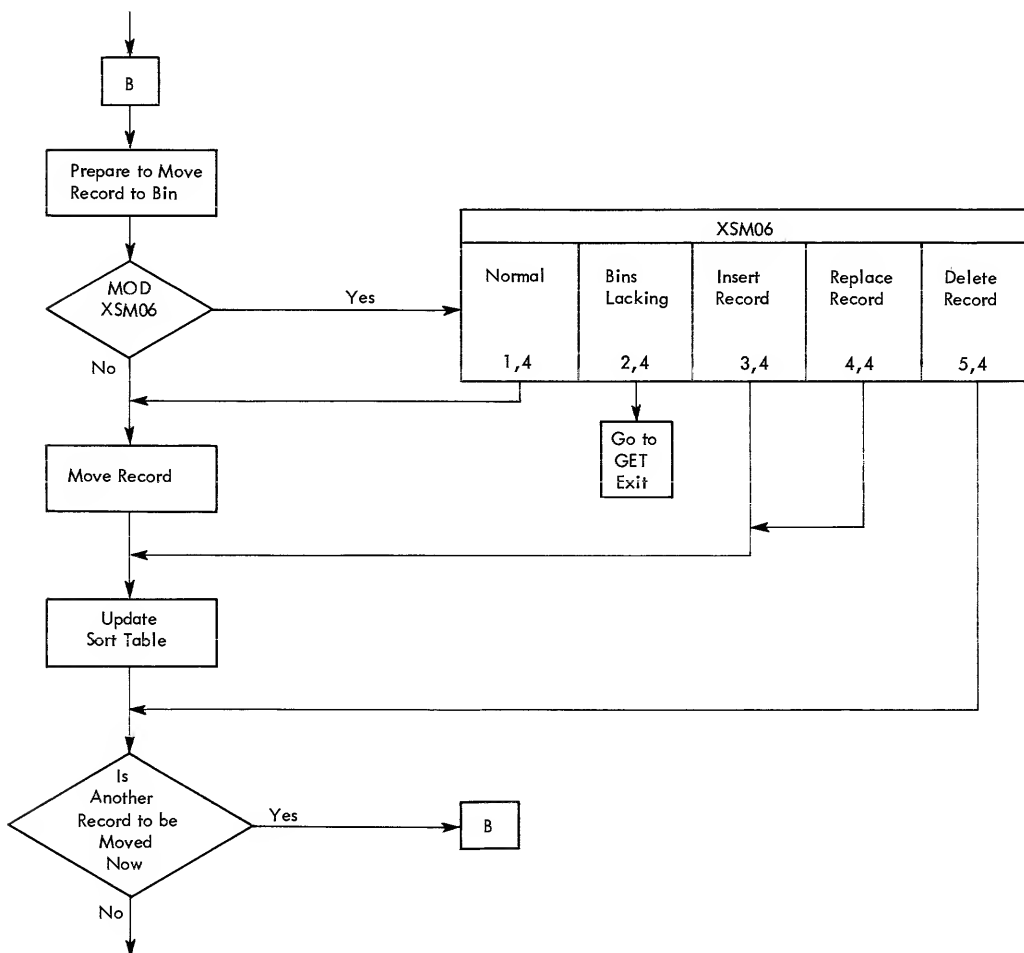


Figure 7. Exit XSM06 (Variable-Length Record Run)

contains the number of words of the record which are in the next bin, the prefix contains 4 (or MZE), and the tag contains 0. The last word of the last bin contains all zeros.

Procedures: The normal return (no records added or deleted) is to 1, 4. The record is moved and processed.

To insert or replace a record when there are not enough bins available to contain the record, return to 2, 4. The records already moved will be sorted. The modification program will be entered again with more available bins before another record is moved.

To insert a record, the location(s) of the bin(s) to use can be found from ERAPR-21 and ERAPR-22. The location of the record to be moved can be found from ERAPR-23. The record must be placed in the bins by the modification program. ERAPR-25 must then be changed to reflect the length of the inserted record, and it must contain the count of words, including the record control word, in the logical record. The return is to 3, 4.

To replace, lengthen, or shorten a record, the modification program must perform the same functions as when it inserts a record. In these cases the return is to 4, 4. The return differs because the GET subprogram must examine the next logical record in the buffer the next time a record is to be moved.

To delete a record, increment CNTPR-9 by 1 and return to 5, 4. The subprogram GET then examines the next logical record in the buffer.

Exit XSM10

Logical Condition at This Point: A label has just been read from an input tape and the LABEL subprogram has been entered to process the label.

Possible Uses of XSM10: The xsm10 exit may be used:

1. To perform extra checking on the label
2. To change the label (in case of nonstandard labels)
3. To delete label checking

Parameter Locations: Key parameters at this point are located at:

LABPR-0, which contains the location of a 20-word area into which the label has been read. Index register 2 contains the complement of this location. It must be restored if the return 1, 4 is used.

The accumulator, which contains the location of the unit control block for the unit from which the label was read. The sign of the accumulator is plus if a standard label is specified on the input FILE card and the input tape label is 84 characters long; it is minus if the label is 120 characters long. The accumulator must be restored if return 1, 4 is used.

The sense indicators, which contain the location of the file data block for the file on which the label occurs. They must be restored if return 1, 4 is used.

Index register 1, which contains either a 3 if the label is a header label or a 4 if it is a trailer label.

Procedures: To continue the label processing routine, the return is to 1, 4.

To delete label processing, the return is to 2, 4.

To reread the label and re-enter the modification program, the return is to 3, 4.

Exit MPM04

Logical Condition at This Point: The control field of the current record is equal to the control field of the previous record during a Merge Phase pass.

Possible Uses of MPM04: The MPM04 exit may be used:

1. To modify the current record
2. To delete the current record
3. To summarize the current record into the previous record

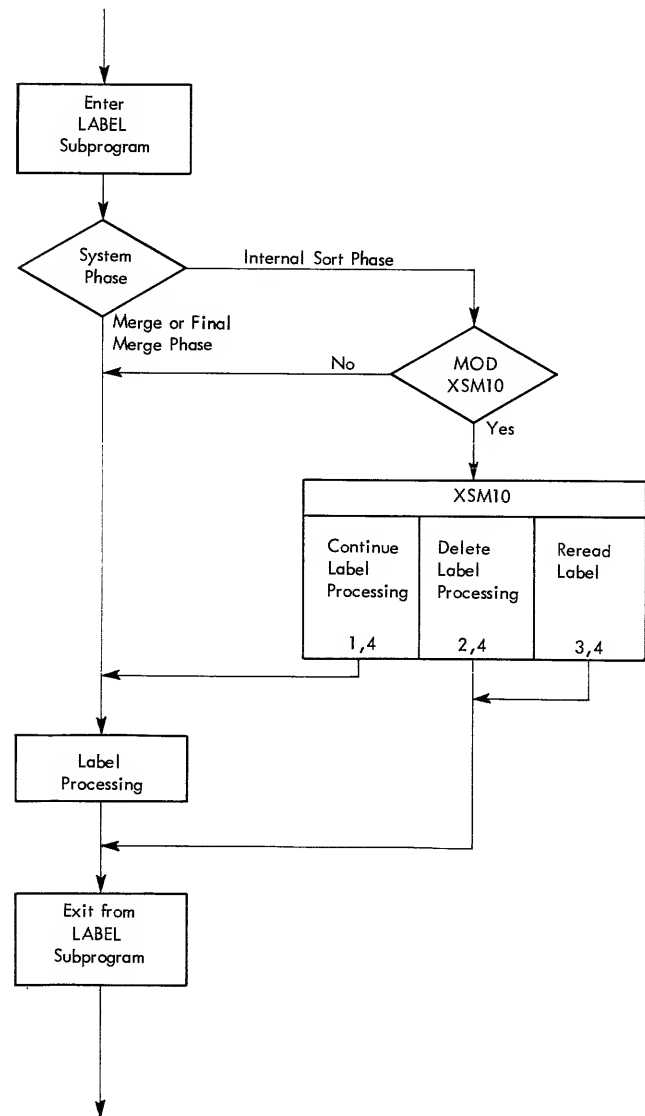


Figure 8. Exit XSM10

Parameter Locations: Key parameters at this point are located at:

The address portion of the accumulator, which contains the location of the first word of the previous logical record. During a variable-length record run, this word is the record control word.

The decrement portion of the accumulator, which contains the location of the first word of the current logical record. During a run involving variable-length records, this word is the record control word.

During a run involving variable-length records, ERAPR-3 and ERAPR-4 contain, respectively, the locations of words indicating the lengths of the previous record and current record.

During a run of fixed-length records, the logical record length is given in CALPR-9.

Procedures: If the current record is to be retained, the return is to 1, 4.

To delete the current record, the return is to 2, 4. This return may also be used when the current record has been summarized into the previous record. If the current record has been summarized into the previous record and if the CKSUMS option is specified, the modification program must recompute the check sum of the modified record. It is not possible to change the length of a record during Merge Phase.

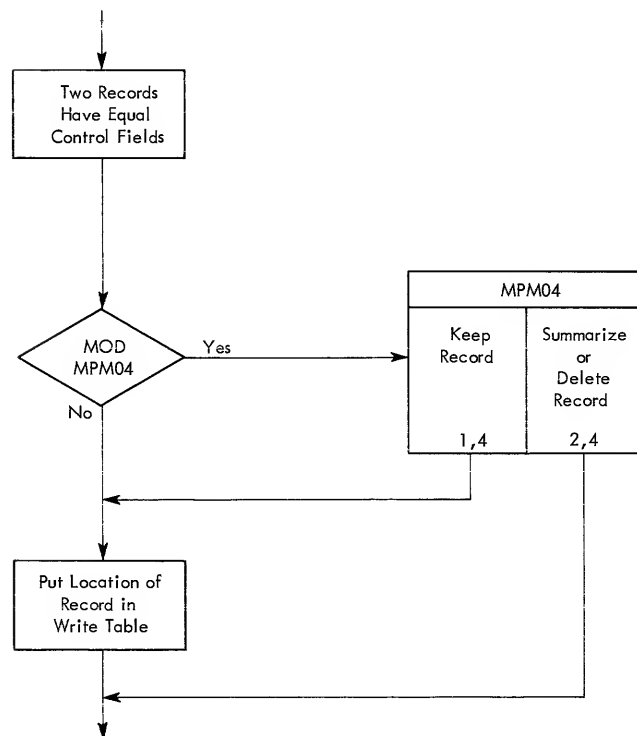


Figure 9. Exit MPM04

Exit FMM02

Logical Condition at This Point: The control field of the current record is equal to the control field of the previous record during the Final Merge Phase.

Possible Uses of FMM02: The FMM02 exit may be used:

1. To summarize the current record into the previous record
2. To delete the current record

Parameter Locations: Key parameters at this point are located at:

ERAPR-14, which contains the location of the first word of the current internal logical record. During a run of variable-length records, the nature of this word depends on the option(s) specified. If either the EQUALS option or both the EQUALS and CKSUMS options are specified, the word is the equals word. If the CKSUMS option (but not the EQUALS option) is indicated, the word is the check-sum word. If neither the EQUALS nor the CKSUMS option is specified, the word is the record control word (which contains the record length).

ERAPR-15, which contains the location of the first data word of the current logical record. During a run of variable-length records, this word is the record control word. For a run of fixed-length records, ERAPR-14 and ERAPR-15 contain the same information because the equals and/or check-sum words are appended to the end of the logical record.

ERAPR-20, which contains the location of the first word of the previous logical record, which has already been moved to the output buffer. The equals and check-sum words have already been deleted from the record if the EQUALS and CKSUMS options were specified.

During a run of variable-length records, ERAPR-12 contains the length of the previous logical record and the accumulator contains the length of the current logical record.

During a run of fixed-length records, CALPR-9 contains the length of each logical record, including the equals and/or check-sum words if the proper options have been specified.

ERAPR-21 which contains the location in the buffer into which the current record will be put if it is not deleted or summarized into the previous record.

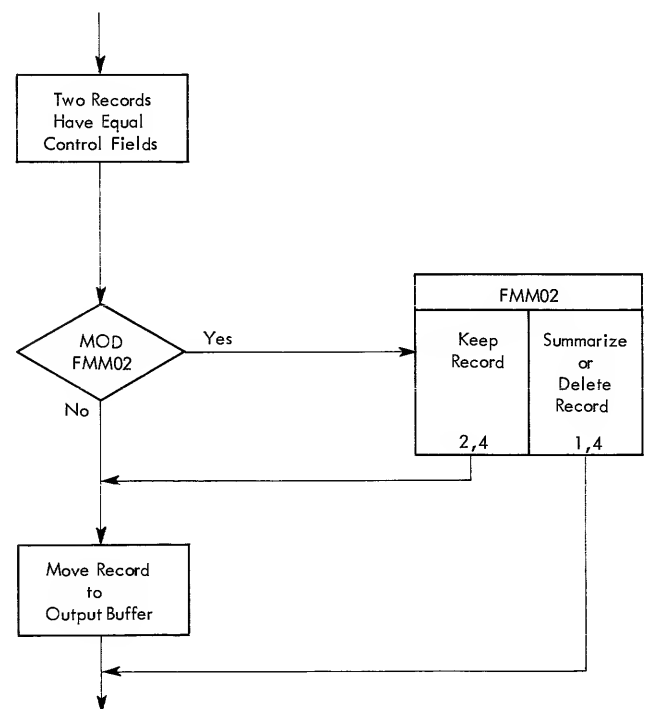


Figure 10. Exit FMM02

Procedures: To delete the current record, the return is to 1, 4. When the current record is summarized into the previous record, the summarizing may cause shortening of the record during a run of variable-length records. In this case, the record-length control word (indicated by ERAPR-20) must be changed. The location of the space for the next record in the buffer (indicated by ERAPR-21) must be updated (i.e., decremented by the number of words by which the record has been shortened). The return is to 1, 4.

If the current record is to be retained, the return is to 2, 4.

Exit FMM04

Logical Condition at This Point: A record has been chosen for moving to the output buffer. Its check sum, if present, has not been checked, and the record has not yet been checked for deletion if the DELETE option is specified.

Possible Uses of FMM04: The FMM04 exit may be used:

1. To delete the record
2. To alter the record

Parameter Locations: Key parameters at this point are located at:

ERAPR-14, ERAPR-15, and CALPR-9, which contain the same information as described for Exit FMM02.

ERAPR-12, which contains the length of the logical record during a run of variable-length records.

ERAPR-2, which contains the number of words in the current output block. This number includes the record to be moved.

Procedures: To delete this record, ERAPR-2 must be decremented by the contents of ERAPR-12. The return is to 1, 4.

To retain the record, the return is to 2, 4. If the record is altered and the CKSUMS option specified, the sum must be recomputed if necessary. It is not possible to alter the length of a logical record at this point.

Exit FMM10

Logical Condition at This Point: Either a label has just been read from an external input tape during a straight merge run or the merge portion of a sort-and-merge run, or a label is about to be constructed for writing on a final output tape.

Possible Uses of FMM10: The FMM10 exit may be used:

1. To perform extra checking of the label
2. To construct the label in a different fashion
3. To change the label
4. To delete label checking

Parameter Locations: Key parameters at this point are located at:

LABPR-0, which contains the location of a 20-word area into which the label has been read or in which the label is going to be constructed. Index register 2 contains the complement of this location. The register must be restored if return 1, 4 is used.

The accumulator, which contains the location of the unit control block for the unit from which the label was read or on which the label is to be written. The accumulator sign is plus if a standard label is specified on the input FILE card and the input tape label is 84 characters long, or if a standard label is specified on the output FILE card and the label to be written is 84 characters long. The sign is minus if either label is 120 characters long. The accumulator must be restored if return 1, 4 is used.

The sense indicators, which contain the location of the file data block for the file on which the label occurs. They must be restored if return 1, 4 is used.

Index register 1, the content of which varies as follows, depending on the operation being performed:

- It is a 3 if a header label is to be checked.
- It is a 4 if a trailer label is to be checked.
- It is a 5 if a header label is to be constructed.
- It is a 6 if an end-of-reel trailer label is to be constructed.
- It is a 7 if an end-of-file trailer label is to be constructed.

Procedures: To continue with label checking or label construction, the return is to 1, 4.

To delete label checking, the return is to 2, 4.

To cause the label to be reread and the modification program to be re-entered, the return is to 3, 4.

To delete label construction, the return is to 3, 4. The label constructed by the modification program will be written.

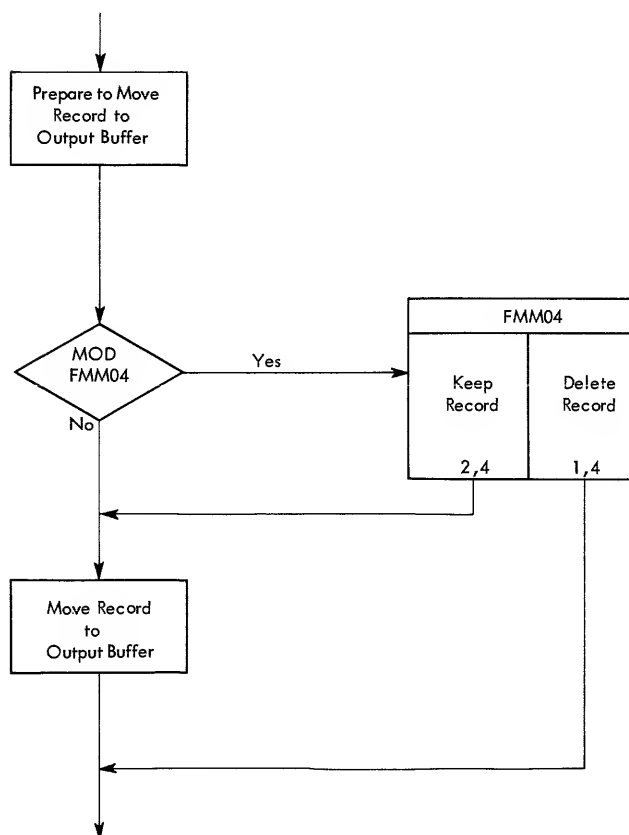


Figure 11. Exit FMM04

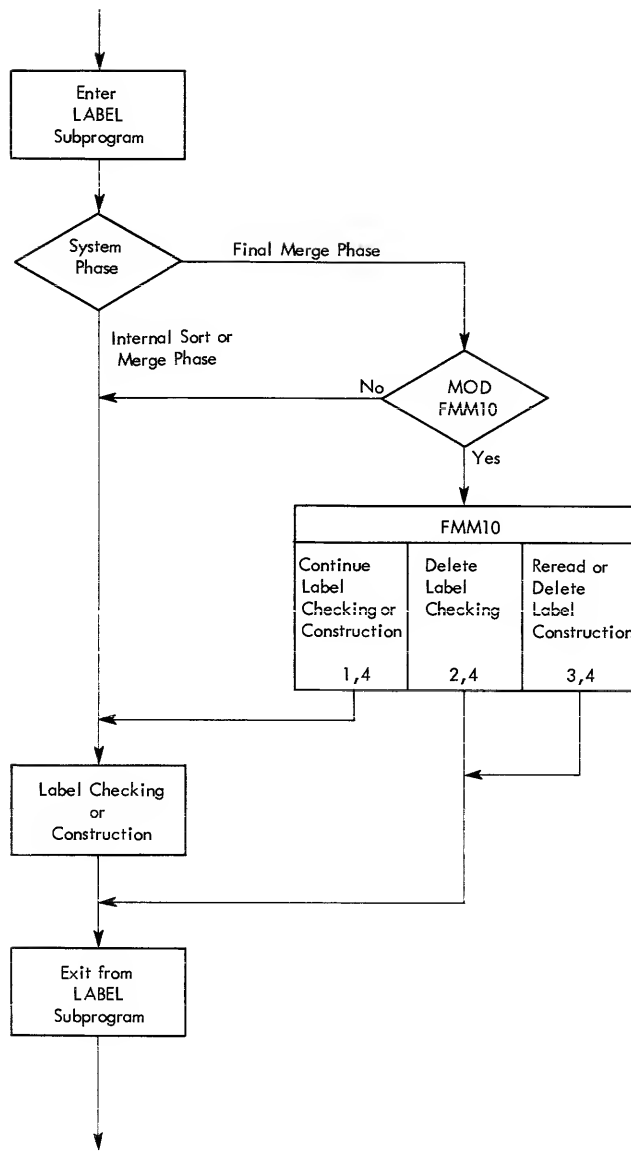


Figure 12. Exit FMM10

Chapter 7. Sort Messages

The messages given below supply the programmer and the operator with information pertinent to errors which may occur during the running of a 7090/7094 Sort job. Many of these messages appear on-line, and they all appear off-line unless either the NOF field is specified on the OPTION card, a SYSOUT unit is not attached, or the message occurs during a routine that is servicing a channel trap.

Following each message is an explanation of the reason for its occurrence and the action(s), if any, which may be taken by the operator. When the nature of the message permits two or more options for the operator, the actions are listed with a numeral prefix.

In the messages, notations such as xx, xxx, and xxxxx, represent actual values of one to five digits in length that appear when a given message is printed.

*CK01 UNIT XX (UNRT) EOT. CHANGE TAPE.

Explanation: The end-of-tape marker was sensed while SYSCK2 was being opened. This indicates a very short tape.

Action: After Sort unloads tape, make another tape ready. Sort reselects the unit.

*CK02 UNIT XX. EOT WRITING DICTIONARIES. CHANGE TAPE. PRESS START FOR RESTART. OPERATOR ACTION PAUSE.

Explanation: The final output tape is too short to accommodate the entire 9PAC Dictionary. The dictionary has been saved from the input tape and is being written on the output tape.

Action: After Sort unloads the tape, mount a longer work tape. Then press START.

*CS02 CKSUM ERROR, RECORD, LOC XXXXX PRESS START TO GO ON.

Explanation: A logical record check sum does not check properly. The record is dumped. This message can occur only during the Merge Phase.

Action: Press START to continue. Processing continues with the next logical record.

*CS03 CKSUM ERROR, RECORD, LOC XXXXX PRESS START TO GO ON.

Explanation: A logical record check sum does not check properly. The record is dumped. This message can occur only during the Final Merge Phase.

Action: Press START to continue. Processing continues with the next logical record.

*EP01 FOLLOWING ERRORS FOUND IN CONTROL CARDS XXXXX XXX XX XXXXX ETC. SORT DELETED.

Explanation: Sort cannot continue. Control returns to the IBSYS System Monitor. The message provides the code number of each of the control card errors found. An explanation of each code number is given below.

*E001 An error was found while a control card read from the card reader was being converted from card image to BCD format.

*E002 A read error, or redundancy, was encountered while reading a control card.

*E003 Some control card has been included more than the allowable number of times. The limits given below are for the number of statements allowed for each sort and/or merge run. Each statement may use one or more continuation cards.

STATEMENT	NUMBER OF TIMES PERMITTED
CHANNELS	1
DELETE	100
FILE	9
LABEL	1
MERGE	1
MODIFICATION	50
OPTION	1
OVERFLOW	1
RECORD	1
RESTART	1
SORT	1

*E004 There is no CHANNELS card; one is required.

*E005 The INPUT parameter has not been correctly specified on the CHANNELS card.

*E006 There are no FILE cards. Both an input FILE card and an output FILE card are required.

*E007 BLOCKSIZE has not been correctly specified on one or more of the FILE cards.

*E008 The CKSUMS and/or BLKSEQ fields have been specified on a FILE card on which decimal mode has also been specified. This is invalid.

*E009 The densities for the DICTIONARY and the LABEL on a FILE card differ.

*E010 Either one of the FILE cards is missing or one of the FILE cards did not have INPUT or OUTPUT specified.

*E011 Two or more output FILE cards have been included; only one is allowed.

*E012 The MODE parameter has not been correctly specified on an input FILE card. All input files must be in the same mode.

*E013 There is no RECORD card; one is required.

*E014 The LENGTH parameters have not been correctly specified on the RECORD card. A length must be given. No more than three lengths are allowed. The input length must not exceed the input block size. In a Sort of fixed-length records, the output length must not exceed the output block size.

*E015 The FIELD parameters have not been correctly specified on the RECORD card. The fields may not exceed the record length. Incorrect parameters are not allowed.

*E016 The FIELD parameter has not been correctly specified on the DELETE card.

*E017 The parameter of the FIELD definer specified for deletion on the DELETE card has not been specified on the RECORD card.

*E018 The IDENT parameter has not been correctly specified on the DELETE card. The identification length must equal the control field length. A check for invalid binary or octal characters should be made.

*E019 The MERGE parameters have not been correctly specified on the CHANNELS card.

- *E020 There is no SORT or MERGE card; one is required.
 - *E021 The ORDER parameter has not been correctly specified on the SORT or MERGE card. A merge order which is not less than two nor greater than eight must be specified.
 - *E022 The FILE parameter has not been correctly specified on the SORT or MERGE card. In order to be sorted, the file must be designated by a FILE card. There should be no FILE cards for files not mentioned on the SORT or MERGE cards.
 - *E023 The ORDER parameter has not been correctly specified on the SORT or MERGE card. For a merge run, the merge order must equal the number of files to be merged. For a sort-and-merge run, it must be at least one greater than the number of external files to be merged in during the Final Merge Phase.
 - *E024 For a run of fixed-length records, the record length is not a factor of block size. The input record length must be a factor of the input block size, and the output record length must be a factor of the output block size.
 - *E025 The number of merge files is greater than the merge order.
 - *E026 The FIELD parameters have not been correctly specified on the SORT or MERGE card. They must correspond to FIELD parameters specified on the RECORD card.
 - *E027 There is no available unit for output on the output channel.
 - *E028 The number of input units specified for the input to a merge-only run does not equal the merge order.
 - *E029 The utility tape requested for input is not attached.
 - *E030 The input channel specified for a merge-only run is not one of the channels specified for merging.
 - *E031 There are not enough units available on the input channel to be assigned to the input function.
 - *E032 There are not enough units available on the merge channels to be assigned to the merge function.
 - *E033 A required parameter has not been specified on a control card.
 - *E034 Too many fields have been specified on a control card.
 - *E035 An invalid field has been specified on a control card.
 - *E036 The same field has been specified more than once on a control card.
 - *E037 A parameter required by a field on a control card has been omitted.
 - *E038 An invalid parameter has been specified on a control card.
 - *E039 The parameter for the RELCOM field on the OPTION card is 10,000 or more. This may not allow enough room for sorting.
 - *E040 The IDENT parameter has not been correctly specified on the LABEL card; an H is required.
 - *E041 The IDENT parameter has not been correctly specified on the LABEL card; it must be at least 18 and not more than 120 characters in length.
 - *E042 The MERGE parameters have not been correctly specified on the CHANNELS card. Exactly two merge channels must be given.
 - *E043 The OUTPUT parameter has not been correctly specified on the CHANNELS card.
 - *E044 The MODE parameter has not been correctly specified on a FILE card.
 - *E045 The DENSITY parameter has not been correctly specified on a FILE card.
 - *E046 The DICTIONARY parameter has not been correctly specified on a FILE card.
 - *E047 The INPUT parameter has not been correctly specified on the input FILE card. An input file number must be given.
 - *E048 The BLOCKSIZE parameter has not been correctly specified on a FILE card.
 - *E049 The PADDING parameter has not been correctly specified on the output FILE card.
 - *E050 The LABEL parameter has not been correctly specified on a FILE card.
 - *E051 The CHECKPOINT parameter has not been correctly specified on the input FILE card.
 - *E052 The PROGRAM parameter has not been correctly specified on the MODIFICATION card.
 - *E053 The LOCATION parameter has not been correctly specified on the MODIFICATION card.
 - *E054 The FORMAT parameter has not been correctly specified on the MODIFICATION card.
 - *E055 The TYPE field has not been correctly specified on the RECORD card.
 - *E056 Too many fields have been specified on the RECORD card.
 - *E057 Control fields of records in BCD mode are not a multiple of six bits in length.
 - *E058 The SEQUENCE field has not been correctly specified on the SORT or MERGE card.
 - *E059 The commercial collating sequence has been requested, but the control fields are not a multiple of six bits in length.
- Action:* No operator action is required for any of the above.
- *EP02 NO END CARD FOUND BEFORE EOF.
 TO DELETE SORT, PUT SS3 UP, START.
 TO CONTINUE AND IGNORE ERROR, PUT SS3 DOWN, START.
 END CARD WILL BE ASSUMED AT THIS POINT.
 OPERATOR ACTION PAUSE.
Explanation: The deck of cards in the card reader is incomplete; it lacks the END card for Sort and the IBSYS control cards that should follow the Sort control cards.
Action: The operator can take one of the following two actions:
1. If deck contains all required Sort control cards, set sense switch 3 down and press START.
 2. If Sort deck is incomplete, set sense switch 3 up and press START. Sort then returns control to the IBSYS System Monitor, which pauses. During pause, provide required IBSYS control cards in card reader.
- *EP03 NOT A SORT CONTROL CARD.
 TO DELETE SORT, PUT SS3 UP, START.
 TO CONTINUE AND IGNORE ERROR, PUT SS3 DOWN, START.
 THE CARD WILL BE IGNORED.
 OPERATOR ACTION PAUSE.
Explanation: Sort has read a card that is not a Sort control card.
Action: The operator can take one of the following two actions:
1. To delete Sort, set sense switch 3 up and press START.
 2. To ignore the card, set sense switch 3 down and press START.
- *EP04 NO SYSCK2 ATTACHED.
Explanation: No SYSCK2 is attached, and either the NOF option has been taken or no SYSOU1 is attached. Sort assumes that the NOCKPT option has been taken,

sets the internal switch indicating that neither dictionaries nor unreadable records will be saved, and continues.
Action: No operator action is required.

*EP05 INTERSYSTEM INPUT UNIT NOT FOUND.
TO DELETE SORT, PUT SS3 UP, START.
TO HAVE SORT ASSIGN AN INPUT UNIT, PUT SS3 DOWN, START.

OPERATOR ACTION PAUSE.

Explanation: Sort cannot locate the intersystem reserve unit specified for input by the CHANNELS control card.

Action: The operator can take one of the following two actions:

1. If the reel(s) of tape containing input is known, set sense switch 3 down and press START. Sort then assigns an input unit and prints the unit number on-line as part of message *EP06.
2. If tape reel containing input is not known, delete Sort by setting sense switch 3 up and pressing START.

*EP06 PREPARE UNITS AS FOLLOWS—
UNIT XX (FUNCTION)
UNIT XX (FUNCTION)
ETC.

PRESS START WHEN ALL UNITS ARE
PROPERLY PREPARED AND IN
READY STATUS.

OPERATOR ACTION PAUSE.

Explanation: The tapes table is printed on-line if the TAPES option is specified. The units are listed in the order in which they are used by Sort.

Each 729 tape unit is checked for ready status; if a unit is not ready the message

NOT IN READY STATUS

is printed after the function of the unit. Hypertape units are not checked for ready status.

Action: Ready units properly and press START.

*IN01 UNIT XX EOF INPUT REEL. LOAD NEXT
REEL ON UNIT XX.

Explanation: The input reels are to be switched.

Action: If unit containing next reel is not ready, make it ready during pause provided by Sort.

*IN02 UNIT XX TRAILER LABEL UNREADABLE. IF
MORE REELS, SET SS3 DOWN.
IF NO MORE REELS, SET SS3 UP—PRESS START.
OPERATOR ACTION PAUSE.

Explanation: The label, which controls the number of input reels, is unreadable.

Action: The operator can take one of the following two actions:

1. If there is another reel of input, set sense switch 3 down and press START.
2. If there are no more input reels, set sense switch 3 up and press START.

*LB01 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL, PUT SS4 UP
TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: Sort has found that the header label read from SYSCK2 at restart time is in error. The label that Sort writes on SYSCK2 contains the name SORT SYSCK2.

Action: The operator can take one of the following two actions.

1. If tape on unit attached as SYSCK2 contains Sort checkpoint, set sense switch 4 down and press START.
2. If tape does not contain checkpoint, mount correct tape on unit attached as SYSCK2, set sense switch 4 up, and press START.

*LB02 UNIT XX BLKCNT ERROR.

Explanation: The trailer label record count does not match the count of blocks on the input tape.

Action: No operator action is required.

*LB03 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL. PUT SS4 UP
TO RETRY. PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The name on the input file label does not match the name on the input FILE card.

Action: The operator can take one of the following two actions.

1. If wrong tape has been mounted, mount correct tape, set sense switch 4 up, and press START.
2. To ignore label, set sense switch 4 down and press START. (Note that because indicators for mode, density, and check-sum block-sequence word from label override indications of input FILE card, care should be taken when label is ignored.)

*LB04 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL. PUT SS4 UP
TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The file serial number on the input file label does not match the number on the input FILE card.

Action: The operator can take one of the following two actions:

1. If wrong tape has been mounted, mount correct tape, set sense switch 4 up, and press START.
2. To ignore label, set sense switch 4 down and press START. (Note that because indicators for mode, density, and check-sum block-sequence word from label override indications of input FILE card, care should be taken when label is ignored.)

*LB05 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL. PUT SS4 UP
TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The reel sequence number on the input file label does not match the number on the input FILE card.

Action: The operator can take one of the following two actions.

1. If wrong tape has been mounted, mount correct tape, set sense switch 4 up, and press START.
2. To ignore label, set sense switch 4 down and press START. (Note that because indicators for mode, density, and check-sum block-sequence word from label override indications of input FILE card, care should be taken when label is ignored.)

*LB06 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL. PUT SS4 UP
TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The name of the intermediate merge tape label does not match the name expected in the label.

Action: The operator can take one of the following two actions:

1. If tape on unit is one just created by Sort, set sense switch 4 down and press START.
2. If a Sort restart, make certain that tapes are mounted correctly. Then set sense switch 4 up and press START.

*LB07 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL. PUT SS4 UP
TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The header label on the input tape does not have the proper first word (IHDR).

Action: The operator can take one of the following two actions:

1. If proper tape has been mounted, set sense switch 4 down and press START.
2. If proper tape has not be mounted, mount correct one, set sense switch 4 up, and press START.

*LB08 UNIT XX, LABEL ERROR. LABEL IS

X X X X X X
X X X X X X

PUT SS4 DOWN TO IGNORE LABEL, PUT SS4 UP TO RETRY, PRESS START.

OPERATOR ACTION PAUSE.

Explanation: The trailer label on the input tape does not have the proper first word (either IEOR or IEOF).

Action: The operator can take one of the following actions:

1. To ignore label, set sense switch 4 down and press START.
2. To read and check label again, set sense switch 4 up and press START.

*LD01 UNIT XX HAS PROGRAM(S) MISSING

XXXXXX MISSING FROM ABOVE UNIT.

TO DELETE SORTSS3 UP

TO GO ONSS3 DN

OPERATOR ACTION PAUSE.

Explanation: One or more Sort subprograms cannot be found and loaded from the IBSYS system unit.

Action: The operator can take one of the following two actions:

1. To delete Sort, set sense switch 3 up and press START. Sort prints

SORT DELETED

and returns control to the IBSYS System Monitor.

2. To continue loading without the missing subprogram(s), set sense switch 3 down and press START. If the missing subprogram(s) is called, Sort is deleted and a core dump is automatically taken.

*LD02 CKSM ERROR LOADING XXXXXX

PRESS START TO GO ON.

Explanation: A check-sum error has occurred while a Sort subprogram was being loaded.

Action: The operator can take one of the following two actions:

1. To ignore check-sum error, press START.
2. To terminate run with a dump, execute manual transfer to location 115s.

*LD03 CONTROL PROGRAM MISSING, XXXXXX

PRESS START TO DELETE SORT.

OPERATOR ACTION PAUSE.

Explanation: The main subprogram of a phase cannot be found and loaded from the system unit.

Action: The operator can take one of the following two actions:

1. To return control to IBSYS System Monitor, press START. Sort prints

SORT DELETED

2. To terminate run with a dump, execute manual transfer to location 115s.

*LE03 COUNTS OF RECORDS DO NOT AGREE. THE COUNTS ARE AS FOLLOWS—

READS WRITES DUMPED
XX XX XX

OPTIONS SS3 SS4

TO DELETE SORTUP UP

TO RETURN TO LAST CKPTUP DN

TO GO ON (IGNORE)DN UP

OPERATOR ACTION PAUSE.

Explanation: The count of the records written and/or dumped due to bad check sums during this pass of Merge Phase does not agree with the count of records read:

Action: The operator can take one of the following three actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To return to last checkpoint if one was taken and if this option is given, set sense switch 3 up, set sense switch 4 down, and press START.
3. To ignore error and continue merging those records written during this pass, set sense switch 3 down, set switch 4 up, and press START.

*LE04 NO READ AREAS AVAILABLE

OPTIONS

SS3 SS4

TO DELETE SORTUP UP

TO RETURN TO LAST CKPTUP DN

OPERATOR ACTION PAUSE.

Explanation: To continue, Merge Phase must read a record from a merge tape. However, there are no buffers available into which records can be read. When this stop occurs, it is probably due to a machine error.

Action: The operator can take one of the following two actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To return to last checkpoint if one was taken and if this option is given, set sense switch 3 up, set sense switch 4 down, and press START.

*LE05

Explanation: The DEBLK subprogram has been entered to dump an unreadable record, but a word count of zero is given, indicating a possible program or machine error.

Action: No operator action is required. To determine if any records were dropped, the programmer should compare the output record counts with the input counts.

*LE10 ERROR, LOC. XX

OPTIONS

SS3 SS4

TO DELETE SORTUP UP

TO RETURN TO LAST CKPTUP DN

TO GO ON (IGNORE)DN UP

Explanation: A logical error has been found at location XX. Using the listing and the load address of the Final Merge Phase found in the map, the user can determine the logical error. In some cases, the option TO GO ON is not given. If no checkpoints have been taken, the option TO RETURN TO LAST CKPT is not given.

Action: The operator can take one of the following four actions:

1. To delete Sort, set sense switches 3 and 4 up and press START. This is the normal action.
2. To restart at last checkpoint if one was taken, set sense switch 3 up, set sense switch 4 down, and press START. For a long Sort run, this might be the option taken.
3. To ignore error and continue, set sense switch 3 down, set sense switch 4 up, and press START. (This option is not recommended.)
4. To terminate run with a dump, execute a manual transfer to location 115s.

*MR01 UNIT XX TO BE USED FOR MERGING.

LOAD THIS UNIT WITH A SCRATCH TAPE.

OPERATOR ACTION PAUSE.

Explanation: Unit XX, which was used for input, is now to be used for merging. Depending upon programmer specifications, Sort either has rewound or has rewound and unloaded the tape.

Action: The operator can take one of the following two actions:

1. If Sort has unloaded the input tape, it does not pause. Mount a work tape and make it ready. Sort selects unit and continues.
2. If Sort has not unloaded input tape, it pauses. Mount a work tape and make it ready. Then press START.

***MR02 UNIT XX LOAD NEXT REEL OF MERGE
FILE YY.**

OPERATOR ACTION PAUSE.

Explanation: The next reel of an external merge file contained on more than one reel must be loaded. Depending upon programmer specifications, Sort either has rewound or has rewound and unloaded the tape.

Action: The operator can take one of the following two actions:

1. If Sort has unloaded previous tape, it does not pause. Mount and make ready next tape. Sort selects unit and continues.
2. If Sort has not unloaded previous tape, it pauses. Mount and make ready next tape. Then press START.

***MR03 EOT WRITING HEADER LABEL—CHANGE
TAPE.**

OPERATOR ACTION PAUSE.

Explanation: The merge tape is too short to contain the header label and end-of-file mark. Sort unloads the tape.

Action: Replace tape with longer work tape. When this tape is ready, press START.

***MR04 ALL INPUT TAPES TO PHASE 2 ARE AT END
OF FILE**

OPTIONS	SS3	SS4
TO DELETE SORT	UP	UP
TO RETURN TO LAST CKPT	UP	DN

Explanation: None of the merge tapes have records on them when the phase begins.

Action: The operator can take one of the following two actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To return to last checkpoint if one was taken and if this option is given, set sense switch 3 up and sense switch 4 down. Then press START.

***MR05 MERGE TAPES TOO SHORT**

OPTIONS	SS3	SS4
TO DELETE SORT	UP	UP
TO RETURN TO LAST CKPT	UP	DN
TO GO ON (IGNORE)	DN	UP

OPERATOR ACTION PAUSE.

Explanation: All merge output tapes are at end of tape. Sort can continue properly only if longer merge tapes are used in a rerun.

Action: The operator can take one of the following three actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To return to last checkpoint if one was taken and if this option is given, set sense switch 3 up, set sense switch 4 down, and press START.
3. To ignore error and to continue, set sense switch 3 down, set sense switch 4 up, and press START.

NOTE: Options 2 and 3 are not recommended.

***OU01 UNIT XX CLOSING OUTPUT REEL NO. XXXX.**

Explanation: An output reel is being closed. The first reel may be other than reel number 1 if a reel sequence number has been specified on the output FILE card.

Action: If reel is to be saved rather than used for a succeeding run during the same job, remove it from unit.

***OU02 UNIT XX MAKE READY FOR NET OUTPUT
REEL**

**WHEN BLANK REEL IS LOADED—PRESS START.
OPERATOR ACTION PAUSE.**

Explanation: Unit XX is to be used for output.

Action: Make unit ready to receive output, and press START.

***OV01 CAPACITY REACHED**

OVERFLOW, BLOCKS/XXXXX

TO STOP INPUT	SS3	UP
TO KEEP READING	SS3	DN

OPERATOR ACTION PAUSE.

Explanation: The capacity of Sort, calculated on the basis of full reels of tape, has been reached. The reading of more input records may cause the merge to be unending.

Action: The operator can take one of the following two actions:

1. To stop reading and to continue with records already read, set sense switch 3 up and press START. (Note that the remaining input can be sorted at a later time using same control information and using OVERFLOW card as specified in message.)
2. If it is known that very few logical records remain on input reel, set sense switch 3 down and press START. (Note that this may cause an unending merge.)

***RD01 UNIT XX FILE XX, RECORD XX
UNRDBL BLK DUMPED YYYYY.**

Explanation: An off-size or redundant block has been read by one of the READ subprograms of the Internal Sort Phase. It cannot be processed and has been written out for user examination. YYYYY is the length of the block. When variable-length records are being read, this message will not appear off-line.

Action: No operator action is required.

***RD02 UNIT XX FILE XX, RECORD XX
INPUT CHKSM ERROR.**

Explanation: The folded IOCS check sum in the last word of tape record XX did not check properly. However, the block is accepted. This message will not appear off-line.

Action: No operator action is required.

***RD03 INPUT BLOCK SEQ ERROR—XX**

Explanation: The block-sequence number in the last word of block XX did not agree with the count in the unit control block. The unit control block is changed. This message will not appear off-line.

Action: No operator action is required.

***RD04 FILE XX, REC XX OFSZ XX WORDS.**

Explanation: An off-size block has been read by the Merge Phase or Final Merge Phase. It is being dumped.

Action: No operator action is required.

***RD05 UNRDBL BLK DUMPED
XXXX WORDS.**

Explanation: An off-size or redundant block has been read by the Merge Phase. It cannot be processed and has been written out for user examination.

Action: No operator action is required.

***RD06 UNRDBL BLK DUMPED
XXXX WORDS.**

Explanation: An off-size or redundant block has been read by the Final Merge Phase. It cannot be processed and has been written out for user examination.

Action: No operator action is required.

***RD07 BLKSEQ ERROR-UCW3 CHGD FROM XX TO XX**

Explanation: An external file being merged during the Final Merge Phase contains a block in which the block count in the check-sum block-sequence word does not agree with the count in the unit control block. The unit control block count is changed. This message will not appear off-line.

Action: No operator action is required.

***RD08 UNIT XX RECORD NO. YY
CKSUM ERROR**

Explanation: The folded IOCS check sum in the last word of tape record YY read as external input during the Final Merge Phase did not check properly. However, the block is accepted. This message will not appear off-line.

Action: No operator action is required.

***RD09 BLKSEQ ERROR-UCW FROM XX TO XX.**

Explanation: The Internal Sort Phase or Merge Phase has written an internal file containing a block in which

the block count does not agree with the count in the unit control block. The unit control block count is changed. This message will not appear off-line.

Action: No operator action is required.

*RD10 UNIT XX APPEARS TO HAVE MALFUNCTIONED.
PRESS START TO DELETE SORT.
OPERATOR ACTION PAUSE.

Explanation: The interrupt at the end of the read instruction on Hypertape drive XX did not signal a normal read or an error condition. Sort cannot continue.

Action: To delete Sort, press START.

*RD11 UNIT XX, FILE XX, RECORD XX
LONG BLK ACCEPTED.

Explanation: A block that is longer than the length specified on the input FILE card has been read by the Internal Sort Phase. It is accepted. This message will not appear off-line.

Action: No operator action is required.

*RP01 SORT INTERRUPT REQUESTED.

1. LABEL AND SAVE ALL TAPES FOR A LATER RESTART. THEN PRESS START.
2. IF SORT IS TO CONTINUE—RESET SS2 AND PRESS START.

OPERATOR ACTION PAUSE.

Explanation: Sense switch 2 is used to request an interrupt of the Sort run during the Merge Phase. If the switch has been set down and if checkpoints are being taken, a pause occurs immediately after the next checkpoint of the phase has been taken.

Action: The operator can take one of the following two actions:

1. If run is to be continued at a later time, label merge tapes with their individual unit numbers. These tapes and the checkpoint tape are saved for use when run is restarted. With sense switch 2 down, press START. Control is then returned to IBSYS System Monitor.
2. If sense switch 2 is inadvertently down and a program interrupt is not desired, set switch up and press START.

*RS01 RESTART FAILED-CHKPNT MISSING OR UNREADABLE.

Explanation: Sort RESTART is being requested, but either there is no checkpoint file or it cannot be read.

Action: No operator action is required.

*SA02 CORE TOO SMALL. SORTING IMPOSSIBLE.
TO DELETE SORT, START.
OPERATOR ACTION PAUSE.

Explanation: The parameters given on the Sort control cards require Sort to use more core storage than is available. Sort cannot continue.

Action: Press START. Sort is deleted, and control is returned to IBSYS System Monitor.

*SQ02 RECORD OUT OF SEQUENCE
THIS RECORD IS AT LOC. XX
LAST RECORD IS AT LOC. XX
UNIT XX IS THE UNIT WHERE
OUT-OF-SORT ORIGINATED

IT IS IN TAPE RECORD NUMBER XXXXX
OPTIONS SS3 SS4
TO DELETE SORT UP UP
TO RETURN TO LAST CKPT UP DN
TO GO ON (IGNORE) DN UP
OPERATOR ACTION PAUSE.

Explanation: A record is not in the correct sequence. This was probably caused by a machine error. This message occurs only during the Merge Phase.

Action: The operator can take one of the following three actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To restart at last checkpoint if this option is given, set sense switch 3 up and sense switch 4 down. Then press START.

3. To ignore error and to continue, set sense switch 3 down, set sense switch 4 up, and press START. The record will be positioned as if it began a new sequence or string. (Note that this action may cause an extra merge pass.)

*SQ03 RECORD OUT OF SEQUENCE

THIS RECORD IS AT LOC. XX
LAST RECORD WAS AT LOC. XX
AND IS NOW AT LOC. XX IN OUTPUT BUFFER.
UNIT XX IS THE UNIT WHERE OUT-OF-SORT ORIGINATED

OPTIONS SS3 SS4
TO DELETE SORT UP UP
TO RETURN TO LAST CKPT UP DN
TO GO ON (IGNORE) DN UP
OPERATOR ACTION PAUSE.

Explanation: A record is not in the correct sequence. This was probably caused by a machine error. This message occurs only during the Final Merge Phase.

Action: The operator can take one of the following three actions:

1. To delete Sort, set sense switches 3 and 4 up and press START.
2. To restart at last checkpoint if this option is given, set sense switch 3 up and set sense switch 4 down. Then press START.
3. To ignore error and continue, set sense switch 3 down, set sense switch 4 up, and press START. (Note that if this option is taken, the output file will contain more than one sequence.)

*VR01 INVALID RECORD FORMAT

RECORD AT LOC. XX
PRESS START TO DELETE SORT
OPERATOR ACTION PAUSE.

Explanation: The record-length control word in an input record does not contain a number within the limits specified on the RECORD control card. Sort cannot continue.

Action: To delete Sort, press START.

*VR03 RECORD, LOC XX INVALID FORMAT
XX WORDS

PRESS START TO DELETE SORT
OPERATOR ACTION PAUSE.

Explanation: The record-length control word of a record that is about to be written in the output file does not contain a number within the limits specified on the RECORD control card. Sort cannot continue.

Action: To delete Sort, press START.

*WR01 EOT ON ALL MERGE TAPES

TO DELETE SORT SS3 UP
TO IGNORE EOT SS3 DOWN
OPERATOR ACTION PAUSE.

Explanation: The Internal Sort Phase has written on each of the merge tapes to the end-of-tape marker without exceeding the tape capacity calculated for full tape reels.

Action: The operator can take one of the following two actions:

1. If it is known that there is very little information remaining on input reel or that end-of-tape markers are far from the end of the tape, set sense switch 3 up and press START.
NOTE: This may result in a tape being pulled off the reel.
2. To delete Sort, set sense switch 3 down and press START. Control is returned to IBSYS System Monitor. (Note that if Sort is rerun at a later time, care should be taken to use longer tapes.)

*WR02 EOT, SYSCK2-NO MORE UNRDBL RECORDS
CAN BE SAVED

PRESS START TO GO ON

Explanation: the DEBLK subprogram has written on SYSCK2 to the end-of-tape marker.

Action: Press START to continue Sort. No more unreadable records are dumped; they are ignored.

Chapter 8. Allocation of Common Storage

Use of Common for Parameter Locations

Many of the Sort subprograms refer to the same parameter locations. These parameters are placed in consecutive storage locations in COMMON, beginning at location 77461 and working downward.

Unless the RELCOM option is specified on the OPTION control card, each group of parameters (i.e., each parameter table) is loaded beginning at the storage location indicated in Table IV.

Table IV: Assembly-Defined Locations for COMMON Parameters

PARAMETER AREA NAME	NUMBER OF PARAM- ETERS	OCTAL STORAGE LOCATION	FUNCTION
OPTPR	15	77461	Option Card Parameters
OVEPR	2	77442	Overflow Card Parameters
LABPR	5	77440	Label Card Parameters
CHAPR	6	77433	Channel Card Parameters
FILPR	14	77425	File Card Parameters
MODPR	50	77407	Modification Card Parameters
RECPR	10	77325	Record Card Parameters
DELPR	2	77313	Delete Card Parameters
SAMPR	7	77311	Sort and Merge Card Parameters
CALPR	50	77302	Calculated Parameters
GENPR	10	77220	General Parameters
RAWPR	30	77206	Read and Write Parameters
CNTPR	20	77150	Count Parameters
ERAPR	30	77124	Erasable Parameters
REFPR	1	77066	Referenced Parameters Parameter

If the RELCOM option is specified, the parameter tables are relocated downward.

Example

The effect of specifying a RELCOM/100 option is illustrated for a few COMMON locations as follows:

COMMON LOCATIONS	PARAMETER LOCATION WITHOUT RELCOM OPTION	PARAMETER LOCATION WITH RELCOM/100 OPTION
FILPR-3	77422	77256
SAMPR-4	77305	77141
MODPR-10	77375	77231
ERAPR-29	77067	76723

Allocation of storage within each of the COMMON areas is given below. In the listing, the single letters appearing in parentheses have the following meanings:

- A Address
- D Decrement
- F Fixed-length records
- T Tag
- V Variable-length records

OPTION Card Parameters

OPTPR-0	RELCOM option: number of words that COM- MON is relocated
-1	CKSUMS option 0 = no 1 = yes
-2	NOCKPT option 0 = no 1 = yes
-3	EQUALS option 0 = no 1 = yes
-4	BUFFER option 0 = no 1 = yes
-5	VARIABLE BLOCK option 0 = no 1 = yes
-6	MAP option 0 = no 1 = yes
-7	NOF (no off-line printing) option 0 = no 1 = yes
-8	HISTORY option 0 = no 1 = yes
-9	TAPE option 0 = no 1 = yes
-10	CARDS option 0 = no 1 = yes
-11	
-12	
-13	
-14	

OVERFLOW Card Parameters

OVEPR-0	Number of blocks for overflow
-1	

LABEL Card Parameters

LABPR-0	Location of 20-word area for label construction
-1	(A) Location of 20-word area for reading label (D) 0 = Label on 729 NZ = Label on 7340
-2	Location of LABEL card, if given
-3	Length of output label in words whether stand- ard or nonstandard
-4	Location of name used in Merge Phase internal labels

CHANNEL Card Parameters

CHAPR-0	(A) Location of input unit(s) UCW (Unit Con- trol Word) Reference Table
	(D) Length of table
-1	(A) Location of output unit(s) UCW Reference Table
	(T) 2
	(D) Length of table (= merge order)

- 2 (A) Location of UCW Reference Table of merge units which are used for output from Internal Sort Phase
(T) 2
(D) Length of table (= merge order)
- 3 (A) Location of UCW Reference Table of other merge channel
(T) 2
(D) Length of table (= merge order)
- 4 Intersystem output
NZ = Intersystem output
0 = Not intersystem output
- 5 Tape available for unreadable records
0 = yes
NZ = no

FILE Card Parameters

- FILPR-0 (A) Location of file data block of input file to a sort
(D) Number of input file
- 1 Location of file data block of final output file
- 2 Location of file data block of first input file to a merge
- 3 } Location of file data block of next input file to a merge
- . }
- . }
- 11 }
- 12 }
- 13 }

MODIFICATION Card Parameters

For each MODIFICATION card parameter location, 0 (zero) indicates no request has been made for the specified exit. NZ (nonzero) indicates a request has been made for the specified exit.

- MODPR-0 XSM01 } User modification words for Internal Sort Phase
- . . }
- . . }
- 9 XSM10 }
- 10 MPM01 }
- . . }
- . . }
- 14 MPM05 }
- 15 FMM01 }
- . . }
- . . }
- 24 FMM10 }
- 25 DXS01 }
- . . }
- . . }
- 34 DXS10 }
- 35 DMP01 }
- . . }
- . . }
- 39 DMP05 }
- 40 DFM01 }
- . . }
- . . }
- 49 DFM10 }

RECORD Card Parameters

- RECPR-0 (F) Record length of input to Internal Sort Phase
(V) Minimum record length

- 1 (F) Record length during Merge Phase
(V) Maximum record length
- 2 (F) Record length of output from Final Merge Phase
(V) Major record length
- 3
- 4
- 5 Record to be sorted or merged
0 = Fixed
NZ = Variable
- 6
- 7
- 8
- 9

DELETE Card Parameters

- DELPR-0 (A) Location of DELETE control fields
(D) Number of DELETE statements
- 1

SORT and MERGE Card Parameters

- SAMPR-0 Collating sequence
0 = Scientific
NZ = Commercial
- 1 Merge order
- 2 Number of external files to be merged
- 3 (A) Location of control field data
(D) Number of control fields
- 4 Merge indicator
0 = Merge only
NZ = Sort or sort and merge
- 5 Sort indicator
0 = Sort only
NZ = Merge or sort and merge
- 6

Calculated Parameters

- CALPR-0 Current run date, YY DDD. Year (YY) and day of year (DDD)
- 1 (F) Number of data records in an input block, i.e., blocking factor
- 2 (F) Number of data records in an output block, i.e., blocking factor
(V) Maximum number of data records in output block
- 3 (V) Internal Sort bin length
- 4 Internal Sort Record Storage Area size, G
- 5 (F) Internal Sort merge table length, L
(V) Internal Sort large table length, one entry per bin
- 6 (F) Internal Sort maximum length of sort, read, or write table, M
(V) Internal Sort maximum length of Sort Table Ratio (L/M)
- 7
- 8 (F) Input record length to Internal Sort Phase
- 9 (F) Record length during Merge Phase
- 10 (F) Output record length from Final Merge Phase
- 11 Sort capacity in number of words
- 12 Number of words in packed extracted control fields
- 13 Maximum merge blocking in words
- 14 Maximum merge blocking in number of data records
- 15 Number of merge areas for Merge Phase
- 16 Number of merge areas for Final Merge Phase
- 17 (V) Maximum merge blocking during Merge Phase
- 18
- 19 (F) (A) Location of low-padding record
(D) Record length of padding record

- 20 (F) (A) Location of high-padding record
(D) Record length of padding record
- 21
- 22
- 23 Available core storage for tables and records in Internal Sort Phase
- 24 Available core storage for tables and records in Merge Phase
- 25 Available core storage for tables and records in Final Merge Phase
- 26 (F) Number of words in input block, including check-sum block-sequence word if specified
(V) Maximum number of data words in input block
- 27
- 28 (F) Number of words in output block
(V) Maximum number of words in output block, i.e., output buffer length
- 29
- 30
- 31 (V) Length of read buffer in Internal Sort Phase
- 32 (V) Number of words in packed extracted control field; if EQUALS option is specified, this number is increased by one
- 33 (V) Maximum number of merge blocks per write request from Internal Sort Phase
- 34 (V) Minimum number of words per write request from Internal Sort Phase
- 35 (V) Length of buffer table in Internal Sort Phase
- 36 (V) Length of locate table in Internal Sort Phase
- 37
- .
- .
- .
- 49

General Parameters

- GENPR-0 Phase indicator
0 = Edit Phase
1 = Internal Sort Phase
2 = Merge Phase
3 = Final Merge Phase
- 1 Mode indicator
0 = Decimal
NZ = Binary
- 2 Pass number during Merge Phase
- 3 (A) Location of RESTART point in checkpoint routine
(D) Complement of index register 4 for use by RESTART for error return (4, 4) to Sort Monitor, accomplishing deletion of Sort
- 4 Location of last executed CALL statement
- 5 Location of last return from a subprogram which had been called
- 6 Label switch
NZ = Standard label on input tape
0 = No label or a nonstandard label on input tape
- 7 The count of the input records is placed here before the trailer label is read
- 8 Dictionary switch
0 = No dictionary specified for output file
NZ = Dictionary specified for output file
- 9 No dump indicator
0 = Normal dumping of unreadable records
NZ = No more unreadable records or records with error conditions can be dumped, but option to continue is taken

Read and Write Parameters

- RAWPR-0 Read-write calling-sequence word number one
- 1 Read-write calling-sequence word number two

- 2 Read completion indicator
0 = Read in progress
NZ = Read complete
- 3 Read EOF indicator
0 = Not at EOF
NZ = At EOF
- 4 Write completion indicator
0 = Write in progress
NZ = Write complete
- 5 EOT indicator
0 = Not at EOT
NZ = EOT on last write
- 6 (F) Number of blocks of external input that can be read into an area in Final Merge Phase
- 7 (A) Logical file number of current read
(D) Logical file number of current write
- 8 (D) Sequence count (string number) during Internal Sort Phase and Merge Phase
- 9 Merge block end word
- 10 Location of file data block for current read
- 11 End-of-reel indicator
- 12 External input switch (NZ = current output tape is external output)
- 13 External input switch (NZ = current input tape is external input)
- 14 Location of table for read calling-sequence word number two
- 15 Location of table for write calling-sequence word number two
- 16 Current read mode
0 = BCD
NZ = Binary
- 17 Current write mode
0 = BCD
NZ = Binary
- 18
- 19 (A) Number of logical records in current short block
(D) Number of words in last data record of current short block
- 20 Hypertape merge switch
0 = At least one merge channel is not 7909
NZ = Both merge channels are 7909
- 21 Backward read indicator
0 = Next (or current) merge pass is forward read
NZ = Next (or current) merge pass is backward read
- 22
- 23 Input to final merge is on Hypertape, and Merge Phase was omitted
0 = no
NZ = yes
- 24
- 25 Overflow switch
0 = Overflow has occurred
NZ = No overflow
- 26
- 27
- 28
- 29

Count Parameters

- CNTPR-0 Count of records sorted and written from Internal Sort Phase
- 1 Count of records merged during Merge Phase
- 2 Count of records merged and written from Final Merge Phase
- 3 Count of words dumped during Internal Sort Phase
- 4 Count of words dumped during Merge Phase

- 5 Count of words dumped during Final Merge Phase
- 6
- 7 Count of blocks dumped during current pass of Merge Phase because check sums do not agree
- 8 Count of records deleted during Internal Sort Phase
- 9 Count of records deleted during current phase
- 10 Count of low-padding records written by Final Merge Phase
- 11 Count of high-padding records written by Final Merge Phase
- 12 Count of records deleted from current Read Table
- 13 Count of tape records written by DEBLK on SYSOU1 or SYSCK2
- 14 Count of records read by Internal Sort Phase
- 15 Number of strings produced by current phase or pass
- 16 Count of records read from external merge tapes by Final Merge Phase
- 17
- 18
- 19

Erasable Parameters

Internal Sort Phase with Fixed-Length Records

- | | |
|---------|---|
| ERAPR-0 | (A) Location of input read buffer
(D) Length of buffer |
| -1 | (A) Location of current Merge Table, L
(D) Length of current L |
| -2 | Location of other Merge Table |
| -3 | Number of dead tags in current L table |
| -4 | Location of next record to be moved from the read buffer if BUFFER option is specified |
| -5 | Location of next available tag in Read Table if BUFFER option is specified |
| -6 | |
| -7 | |
| -8 | |
| -9 | Calling-sequence word to XTRACT
(A) Location of Sort Table
(D) Length of table |
| -10 | |
| -11 | Calling-sequence word to DELETE
(A) Location of last Read Table
(D) Length of table |
| -12 | |
| . | |
| . | |
| . | |
| -18 | Delete Sort switch |
| -19 | |
| -20 | Location of file number in merge label name |
| -21 | (A) Location of Read Table
(D) Length of table |
| -22 | Location of Write Table |
| -23 | (A) Location of Sort Table
(D) Length of table |
| -24 | Number of dead tags in last Read Table |
| -25 | |
| -26 | (A) Location of dead tags for WRITE to move for future reading
(D) Number of dead tags |
| -27 | (A) Location of live tags for writing
(D) Number of live tags |
| -28 | |
| -29 | |

Internal Sort Phase with Variable-Length Records

- | | |
|---------|--|
| ERAPR-0 | (A) Location of Sort Table
(D) Length |
| -1 | (A) Location of Buffer Table
(D) Length of table |
| -2 | (A) Location of Locate Table
(D) Length of table |
| -3 | (A) Location of current Availability Table
(D) Length of table |
| -4 | (A) Location of Availability Table, after which PUT builds the Write Table
(D) Length of table |
| -5 | Location of last record being written |
| -6 | Number of records in last call to PUT |
| -7 | Length of last L Table |
| -8 | Length of last L Table |
| -9 | (A) Location of Sort Table
(D) Length of Sort Table |
| -10 | (A) Location of Block Table for PUT
(D) Length of Block Table |
| -11 | Calling-sequence word to DELETE
(A) Indirect location of record to be checked for deletion
(D) 1 |
| -12 | Number of words in packed control fields, plus one if EQUALS option is specified |
| -13 | Length from beginning of PUT list in L to base of L |
| -14 | |
| -15 | |
| -16 | |
| -17 | Number of words to be written by current PUT |
| -18 | Delete Sort switch |
| -19 | |
| -20 | Location of file number in merge label name |
| -21 | (A) Core-storage location just before Availability Table
(T) 1 |
| -22 | Complement of number of bins in Availability Table |
| -23 | Core-storage location just before record control word of next record |
| -24 | Equals word (sequence number) |
| -25 | Current record length |
| -26 | |
| -27 | |
| -28 | |
| -29 | |

Merge Phase

- | | |
|---------|---|
| ERAPR-0 | |
| -1 | |
| -2 | |
| -3 | (V) Location of word containing length of previous record |
| -4 | (V) Location of word containing length of current record |
| -5 | |
| -6 | |
| -7 | |
| -8 | |
| -9 | Location of current record for XTRACT routine |
| . | |
| . | |
| . | |
| -17 | |
| -18 | Delete Sort switch |
| -19 | NZ = odd-numbered pass when both merge channels are 7909 |
| -20 | Location of file number in merge label name |
| -21 | Location of pass number in merge label name |

- 22
- .
- .
- .
- 27
- 28 Number of strings in last pass divided by merge order
- 29 Switch to change XTRACT to alternate ascending-descending sequence

Final Merge Phase

ERAPR-0

- 1 Count of records which have been placed in output buffer
- 2 Current output block size in words
- 3 (A) Base location of ADDR Table
(T) 2
- 4 (A) Base location of ARWD Table
(T) 2
- 5 (A) Base location of FLWD Table
- 6 Location of current output buffer
- 7 Base location of sequence-check control field
- 8 Indirect base location of data portion of current merge record
- 9 Location of current record for XTRACT
- 10 Base location of entire current merge record
- 11 Calling-sequence word to DELETE
(A) Indirect location of record to be checked for deletion
(D) 1
- 12 Length of output data record in words
- 13 Length of entire record in words
- 14 Location of data record
- 15 Location of first word of data in the record
- 16 Indirect location of first word of data in the record
- 17 Number of words preceding data in the record
- 18 Delete Sort switch
- 19
- 20 At initialization time—location of file number in merge label name
During merging—location of record in output buffer
- 21 Location of next available word in output buffer
- 22 0 = Keep this data record
NZ = Drop this data record
- 23 (A) Number of file currently being read
(D) Number of input buffer
- 25 Cumulative number of records read
- 26 External order of merge
- 27 Internal order of merge
- 28 Read-demand switch
- 29 Write-request switch

Referenced Parameters Parameter

- REFPR-0 Location of last word used by referenced parameters

Input and Output File Data Block

Information on the input and output files of a sort and/or merge run is taken from the parameters of the FILE control cards for that run. The information for each file is stored in a 25-word block, arranged as follows:

WORD	CONTENTS	USED ON	
		INPUT	OUTPUT
1	Mode 0 = decimal (assumed if omitted) NZ = binary	X	X
2	Density 0 = high (assumed if omitted) NZ = low	X	X
3	Padding 0 = no padding (assumed if omitted) 1 = low padding 2 = high padding	X	X
4	Label 0 = Standard 1 = nonstandard 2 = no label (assumed if omitted)		X
5	Label density 0 = high (assumed if omitted) NZ = low	X	X
6	Block size (must be given)	X	X
7	Serial number (checked if given)	X	X
8	Reel-sequence number (checked if given)	X	X
9	Block check sums 0 = no (assumed if omitted) NZ = yes	X	X
10	Block-sequence number 0 = no (assumed if omitted) NZ = yes	X	X
11	Dictionary 0 = no (assumed if omitted) NZ = yes	X	X
12	Name (checked if given)	X	X
13	Name	X	X
14	Name	X	X
15	Input number (must be given)	X	
16	Number of input reels (1 if not given)	X	
17			
18	Checkpoint 0 = standard 1 = nonstandard 2 = no checkpoint (assumed if omitted)	X	
19	Number of retention days		X
20	Block check sums or block sequence 0 = neither NZ = one or both	X	X
21	Grouping factor	X	X
22	Number of reels processed to date	X	
23	Block size plus check sum or sequence word	X	X
24	Field-length blocking—number of records/block	X	X
25			

Updating and Editing 7090/7094 Sort

The IBM 7090/7094 Generalized Sorting System occupies two consecutive files on the IBSYS system tape. The first file consists of one program, named Sort, which is assembled in absolute form and has its origin at SYSORG. Sort contains the Sort Monitor and Sort Subprogram Binary (ssb) Loader and is loaded when the

1	16
/EXECUTE	SORT

control card is read. For each phase of the sort-and-merge run, Sort loads the appropriate subprograms from the second file and passes control to the main program of each phase.

The second file contains several subprograms, each assembled in relocatable form and consisting of one tape record formed by blocking the column-binary card images for the subprogram. User modification programs can be inserted at the end of this file. After control card analyses, Sort determines which subprograms are to be loaded during each phase so that maximum space in core storage is provided for sorting at object time.

The IBSYS System Editor, IBEDT, does not allow octal or binary modifications to be made to relocatable subprograms but does provide for insertion and/or replacement of subprograms.

To update one or more of the subprograms in 7090/7094 Sort, it is necessary to:

1. Assemble the subprograms: IBSFAP places the relocatable card images of the assembled subprograms on SYSPP1.

2. Reassign SYSPP1 to the SYSUT2 function.

3. Build a new system type using IBEDT and a TAPE *REPLACE card for each subprogram being replaced. A TAPE *INSERT card is used for each modification subprogram being inserted. When IBEDT finds the position where a newly assembled subprogram is to be inserted, it blocks the binary card images and provides the necessary header words and the required transfer card. The header words are described under "Standard System Library Record Formats" in the publication *IBM 7090/7094 IBSYS Operating System: System Monitor (IBSYS)* Form C28-6248.

The symbolic tape distributed with the Sort package contains symbolic card images blocked 16 cards per block except for the END cards, which are unblocked. Normal rules for doing a FAP update are provided in the publication *IBM 709/7090 Programming Systems:*

FORTTRAN Assembly Program (FAP), Form C28-6235. The symbolic tape has subprograms arranged on it so that the serializations beginning in column 73 have the order given in the section "Sort Subprograms and Communication."

To illustrate the method of correcting and assembling subprogram nnn, which may follow another subprogram mmm, the following card sequence is used:

1	7	16	73
	*FAP		
	UPDATE	x, y, D	
	ENDUP		mmmZZZZZ
	*FAP		
	UPDATE	x, y	
(Correction Cards)	END		nnnZZZZZ

where x and y are logical tape numbers (IBSFAP uses 8, 9, and 10 for updating). The zzzzz component represents a quantity at least as large as the number in the last card of the subprogram being considered.

The first three cards space the symbolic tape past subprogram mmm, the "D" specifying assembly deletion. The remaining cards specify assembly of nnn.

Sort Modification Letters

In order to facilitate the release of modifications to the field, the procedure is as follows:

Modifications are released in the form of symbolic card corrections, together with control cards which allow the symbolic card deck to be placed on a tape attached as SYSIN1 and used during an IBSYS system run. IBSFAP and IBEDT are then used to produce an updated symbolic tape and an updated IBSYS system tape. Updating with this deck is always from the latest modification level of the Sort system. Accompanying the symbolic card corrections are the binary cards for each of the subprograms which are being changed. These binary cards may be placed on a tape attached as SYSUT2 and used by the IBSYS System Editor, IBEDT, to replace the corresponding subprograms on the old system tape to produce a new system tape. Use of only the binary cards does not result in a new listing or a new symbolic input tape.

In conjunction with the above symbolic deck, instructions on the maintenance of a master update deck are distributed with each modification. This master updates from modification level 0 to the latest level. Therefore, users who do not want to update for every

modification can reassemble and bring their own system up to the latest level with only one assembly. Assembly is performed without renumbering columns 73-80. This provides the user with an up-to-date listing of the reassembled subprograms. At the same time, a common communication medium is provided so that several modifications can be made to the same subprogram within a given version.

When a new version of IBSYS is distributed, the Sort on the IBSYS system tape is at the latest modification level. The user needs to update Sort when he receives a new IBSYS version only if he is using modification programs on the IBSYS system tape or if he has put his own modifications into the system.

For the following example, which updates all subprograms of Sort and replaces them on the IBSYS system tape, assume the following SYSUNI table and FAP logical tape numbers. Note that material enclosed in brackets [] is optional, subject to the tape density settings of the installation.

SYSUNI TABLE			
FUNCTION	UNIT	DENSITY	FAP LOGICAL TAPE NUMBER
SYSLB1	A1	High	
SYSOU1	B1		
SYSIN1	A2		
SYSPP1	B2		
SYSCK1	None		9
SYSCK2	None		10
SYSUT1	A3	High	
SYSUT2	B3	High	8
SYSUT3	A4	High	
SYSUT4	B4	High	

Attached unit not assigned or reserved:

A5
B5
.
.
.

The control cards for updating Sort are as follows:

1	7	16	73
(\$JOB (Identification)			
\$IBSYS			
\$DATE mmdyy			
\$ATTACH B3			
\$AS SYSUT2 [, H]			
\$ATTACH A5			
\$AS SYSCK1 [, H]			
\$ATTACH B2			
\$AS SYSPP1 [, H]			
\$EXECUTE IBSFAP			
*FAP (SORT)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (HYSTAR)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (IOPEN)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			

1	7	16	73
*FAP (LABEL)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (BTD)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (CALC)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (EP001)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (RB01)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (RELEAS)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (SK001)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (VXS)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (MRGIO)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (BUFRD)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (XTRACT)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (FXS)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (GET)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (PUT)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (READ)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (WRITE)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (WTFIX)			
UPDATE 8, 9			
(Correction Cards, if any)			
END			
*FAP (DEBLK)			
UPDATE 8, 9			
(Correction Cards, if any)			

1	7	16	73
END			EDDZZZZZ
*FAP	(FIMRG)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			EVFZZZZZ
*FAP	(MERGE)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			EVMZZZZZ
*FAP	(POSTP)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			FPPZZZZZ
*FAP	(CKPT)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			GCKZZZZZ
*FAP	(DELETE)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			GDEZZZZZ
*FAP	(HYFIMR)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			HFMZZZZZ
*FAP	(MRGHYO)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			HIOZZZZZ
*FAP	(HYMERG)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			HMRZZZZZ
*FAP	(HYOPEN)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			HOPZZZZZ
*FAP	(HYGET)		
UPDATE 8, 9			
(Correction Cards, if any)			
END			HYGZZZZZ
*FAP			
UPDATE 0, 9, U, D			(((((0
END			(((((1
ENDUP			(((((1
\$IBSYS			
\$ENDFILE	SYSPP1		
\$REWIND	SYSPP1		
\$SWITCH	SYSPUT2, SYSPP1	READY BINARY	
		FOR IBEDT.	
\$REMOVE	SYSPP1	SAVE OLD	
		SYMBOLIC TAPE.	
\$REMOVE	SYSCK1	SAVE NEW	
		SYMBOLIC TAPE.	
\$IBEDT			
*EDIT	HIGH, MAP		
TAPE *REPLACE	SORT		
TAPE *REPLACE	HYSTAR		
TAPE *REPLACE	IOPEN		

1	7	16	73
TAPE *REPLACE		LABEL	
TAPE *REPLACE		BTD	
TAPE *REPLACE		CALC	
TAPE *REPLACE		EP001	
TAPE *REPLACE		RB01	
TAPE *REPLACE		RELEAS	
TAPE *REPLACE		SK001	
TAPE *REPLACE		VXS	
TAPE *REPLACE		MRGIO	
TAPE *REPLACE		BUFRD	
TAPE *REPLACE		XTRACT	
TAPE *REPLACE		FXS	
TAPE *REPLACE		GET	
TAPE *REPLACE		PUT	
TAPE *REPLACE		READ	
TAPE *REPLACE		WRITE	
TAPE *REPLACE		WTFIX	
TAPE *REPLACE		DEBLK	
TAPE *REPLACE		FIMRG	
TAPE *REPLACE		MERGE	
TAPE *REPLACE		POSTP	
TAPE *REPLACE		CKPT	
TAPE *REPLACE		DELETE	
TAPE *REPLACE		HYFIMR	
TAPE *REPLACE		MRGHYO	
TAPE *REPLACE		HYMERG	
TAPE *REPLACE		HYOPEN	
TAPE *REPLACE		HYGET	
(eof card)			
\$IBSYS			
\$REWIND		SYSUT2	
\$STOP			(EOJ)

The new system tape is now on SYSUT1, and the new symbolic tape is on SYSCK1 (unloaded).

Removing Hypertape Subprograms

The following control card deck may be used to remove from the IBSYS system tape those programs that are used only during sort and/or merge runs that use IBM 7340 Hypertape Drives.

1	7	16	73
\$ATTACH		A3	
\$AS		SYSUT1[, H]	
\$IBEDT			
*EDIT		MAP, MODS	
*REMOVE		HYFIMR	
*REMOVE		MRGHYO	
*REMOVE		HYMERG	
*REMOVE		HYGET	
(eof card)			
\$IBSYS			
\$STOP			

The new IBSYS system tape, with four subprograms removed, is created on SYSUT1.

Appendix

Sample Problem

The example which follows is part of an actual Sort run. It is used to illustrate the procedures to be followed in obtaining the desired results.

It is desired to sort a 10,000 record binary file consisting of 100 blocks of tape records. Each block contains 100 ten-word logical data records (block size equals 100). The output is to consist of 100 tape-record blocks of 100 ten-word logical records each.

The control field for sorting is the first word of each logical data record. The scientific collating sequence is to be used, and the sort is to be in ascending order. The input and output tape drives are to be set for high density. Though not necessary for the running of this job, various fields have been specified on an `OPTION` control card to illustrate the on-line printing that they cause.

The required Sort control cards are:

```
1 7
CHANNEL, INPUT/B, MERGE/(A, B)
FILE, INPUT/1, REEL/1, DENSITY/H, MODE/B,
BLOCKSIZE/1000
RECORD, LENGTH/10, TYPE/F, FIELD/(6, 6, 6)
FILE, OUTPUT, DENSITY/H, MODE/B,
BLOCKSIZE/1000
SORT, SEQUENCE/S, ORDER/3, FIELD/1, FILE/1
END
```

The `OPTION` card could have the following format and, if used, would be inserted before the `END` card.

```
1 7
OPTION, MAP, HISTORY, CARDS, MAPS
```

To sort this 10,000-record input data file, the procedure is as follows:

1. Mount data tape on channel B.
2. Mount `SYSLB1` on `A1`.
3. Ready three additional tapes on each channel.
4. Prepare the control card deck and place it in the card reader.¹

5. Set sense switch 1 down and press the Load Tape button.

If the `OPTION` card is not used, the on-line printout associated with this run appears in Figure 13. The corresponding off-line printout for this same condition is shown in Figure 14. If the `OPTION` card is included, both the on-line and the off-line printouts are as shown in Figure 15.

Figure 16 is a reproduction of the first thirty-two logical data records of the input tape. The first word of each record is underlined for identification. The first thirty-two output logical data records, again with the first data word underlined, are shown in Figure 17.

Figure 18 shows the section of the output which contains the first input record. This record is located and the 17th data record of the eighth (tenth octal) output tape record. The first word has been underlined.

```
$RELEASE      SYSPPI
$RELEASE      SYSUT1
$RELEASE      SYSUT2
$RELEASE      SYSUT3
$RELEASE      SYSUT4
$ATTACH       B6
$AS           SYSCK2,H
$ATTACH       RDA
$AS           SYSIN1
$EXECUTE      SORT
UNIT  A4  CLOSING OUTPUT REEL NO. 0001  *OU01
```

END OF SORT

```
$IBSYS
$STOP
```

PERIPHERAL UNIT POSITIONS AT END OF JOBS

```
SYSPPI  NO UNIT   REC.    0, FILE    0
SYSOU1  IS  A3   REC. 00101, FILE 00000
SYSIN1  IS  RDA   REC. 00018, FILE 00000
```

END OF JOBS

Figure 13. On-Line Printout Without `OPTION` Card

¹ This deck is inserted in the order shown on the off-line listing accompanying this example. The `$IBSYS` and the `$STOP` cards would follow the `END` card at this point.

```

$RELEASE      SYSPP1
$RELEASE      SYSUT1
$RELEASE      SYSUT2
$RELEASE      SYSUT3
$RELEASE      SYSUT4
$ATTACH       B6
$AS           SYSCK2,H
$ATTACH       RDA
$AS           SYSIN1
$EXECUTE      SORT
      PROGRAM          LOAD ADDRESS
      HYSTAR           05654
      IOPEN            06165
      LABEL            10546
      BTD              11412
      CALC             11510
      EP001            15466
      RB01             33425
      RELEAS           33705
      SK001            34012

```

CHANNEL, INPUT/B, MERGE/(A,B)

FILE, INPUT/1, REEL/1, DENSITY/H, MODE/B, BLOCKSIZE/1000

FILE, OUTPUT, DENSITY/H, MODE/B, BLOCKSIZE/1000

RECCRD, LENGTH/10, TYPE/F, FIELD/(6,6,6)

SCRT, SEQUENCE/S, ORDER/3, FIELD/1, FILE/1

END

MERGE BLOCKING (RECORD/TAPE BLOCK) 200

PREPARE UNITS AS FOLLOWS-- *EP06

```

UNIT  B2  INPUT TAPE
UNIT  A4  MERGE TAPE
UNIT  A5  MERGE TAPE
UNIT  A6  MERGE TAPE
UNIT  B1  MERGE TAPE
UNIT  B4  MERGE TAPE
UNIT  B5  MERGE TAPE
UNIT  B6  CHECKPOINT TAPE
      PROGRAM          LOAD ADDRESS
      HYSTAR           05654
      IOPEN            06165
      LABEL            10546
      BTD              11412
      XTRACT           11510
      FXS              12175
      READ             14032
      WRITE            15373
      DEBLK            16176
      CKPT             16667

```

UNIT B2 WAS FINAL REEL OF INPUT

Figure 14. Off-Line Printout Without OPTION Card (Sheet 1 of 2)

INTERNAL SORT PHASE COMPLETED. 10000 RECORDS SORTED.

PROGRAM	LOAD ADDRESS
HYSTAR	C5654
IOPEN	C6165
LABEL	10546
BTO	11412
MKGIO	11510
XTRACT	13253
DEBLK	13740
MERGE	14431
CKPT	20217

MERGE PHASE PASS 1 COMPLETED. RECORD COUNT 10000
MERGE PHASE COMPLETED

PROGRAM	LOAD ADDRESS
HYSTAR	C5654
IOPEN	C6165
LABEL	10546
BTO	11412
RELEAS	11510
MKGIO	11615
XTRACT	13360
DEBLK	14045
FIMRG	14536
PCSTP	17672
CKPT	20245

UNIT A4 CLOSING OUTPUT REEL NO. 0001 *OU01

	PHASE 1	PHASE 2	PHASE 3
COUNT OF INPUT RECORDS TO SORT			
ANC/OR MERGE	10000	N/A	N/A
COUNT OF RECORDS SORTED OR MERGED	10000	10000	10000
COUNT OF WORDS DUMPED	0	0	0
COUNT OF RECORDS DELETED	0	N/A	0
COUNT OF HIGH PADDING RECORDS IN OUTPUT	N/A	N/A	0
COUNT OF LOW PADDING RECORDS IN OUTPUT	N/A	N/A	0

END OF SORT

\$IBSYS
\$STCP

PERIPHERAL UNIT POSITIONS AT END OF JOBS

SYSPP1	NO UNIT	REC. 0, FILE 0
SYSOU1	IS A3	REC. 00101, FILE 00000
SYSIN1	IS R0A	REC. 00018, FILE 00000

END OF JOBS

Figure 14. Off-Line Printout Without OPTION Card (Sheet 2 of 2)

```

$RELEASE      SYSPP1
$RELEASE      SYSUT1
$RELEASE      SYSUT2
$RELEASE      SYSUT3
$RELEASE      SYSUT4
$ATTACH       B6
$AS           SYSCK2,H
$ATTACH       RDA
$AS           SYSIN1
$EXECUTE      SORT
PROGRAM      LOAD ADDRESS

```

```

HYSTAR      05654
IOPEN       06165
LABEL       10546
BTD         11412
CALC        11510
EP001       15466
RB01        33425
RELEAS      33705
SK001       34012

```

```

OPTION ,MAP ,HISTORY ,CARDS ,TAPES
CHANNEL, INPUT/B, MERGE/(A,B)
FILE, INPUT/1, REEL/1, DENSITY/H, MODE/B, BLOCKSIZE/1000
FILE, OUTPUT, DENSITY/H, MODE/B, BLOCKSIZE/1000
RECORD, LENGTH/10, TYPE/F, FIELD/(6,6,6)
SORT, SEQUENCE/S, ORDER/3, FIELD/1, FILE/1
END

```

```

MERGE BLOCKING (RECORD/TAPE BLOCK)      200

```

```

PREPARE UNITS AS FOLLOWS--      *EP06

```

```

UNIT  B2  INPUT TAPE
UNIT  A4  MERGE TAPE
UNIT  A5  MERGE TAPE
UNIT  A6  MERGE TAPE
UNIT  B1  MERGE TAPE
UNIT  B4  MERGE TAPE
UNIT  B5  MERGE TAPE
UNIT  B6  CHECKPOINT TAPE

```

```

PRESS START WHEN ALL UNITS ARE PROPERLY PREPARED AND IN READY STATUS.

```

```

OPER. ACTION PAUSE

```

```

..CONTINUING

```

```

PROGRAM      LOAD ADDRESS

HYSTAR      05654
IOPEN       06165
LABEL       10546
BTD         11412
XTRACT      11510
FXS         12175
READ        14032
WRITE       15373
DEBLK       16176
CKPT        16667

```

Figure 15. On-Line and Off-Line Printout with OPTION Card (Sheet 1 of 2)

UNIT B2 WAS FINAL REEL OF INPUT

INTERNAL SORT PHASE COMPLETED. 10000 RECORDS SORTED.

PROGRAM	LOAD ADDRESS
HYSTAR	05654
IOPEN	06165
LABEL	10546
BTD	11412
MRGIO	11510
XTRACT	13253
DEBLK	13740
MERGE	14431
CKPT	20217

MERGE PHASE PASS 1 COMPLETED. RECORD COUNT 10000
MERGE PHASE COMPLETED

PROGRAM	LOAD ADDRESS
HYSTAR	05654
IOPEN	06165
LABEL	10546
BTD	11412
RELEAS	11510
MRGIO	11615
XTRACT	13360
DEBLK	14045
FIMRG	14536
POSTP	17672
CKPT	20245

UNIT A4 CLOSING OUTPUT REEL NO. 0001 *OU01

	PHASE 1	PHASE 2	PHASE 3
COUNT OF INPUT RECORDS TO SORT			
AND/OR MERGE	10000	N/A	N/A
COUNT OF RECORDS SORTED OR MERGED	10000	10000	10000
COUNT OF WORDS DUMPED	0	0	0
COUNT OF RECORDS DELETED	0	N/A	0
COUNT OF HIGH PADDING RECORDS IN OUTPUT	N/A	N/A	0
COUNT OF LOW PADDING RECORDS IN OUTPUT	N/A	N/A	0

END OF SORT

\$IBSYS
\$STOP

PERIPHERAL UNIT POSITIONS AT END OF JOBS

SYSPP1	NO UNIT	REC. 0, FILE 0
SYSOU1	IS A3	REC. 00105, FILE 00000
SYSIN1	IS RDA	REC. 00019, FILE 00000

END OF JOBS

Figure 15. On-Line and Off-Line Printout with OPTION Card (Sheet 2 of 2)

END OF FILE

BINARY	TAPE 02223	RDS (00000)8	FILES	RDS (00000)8	RECCRDS
RECORD 00001	(01750)8	(01000)10	WORDS		
00000	045364030154	-146130347644	-123374243534	212744050627	132060424151
00010	334042301065	327773606673	-216271142057	-253215471407	-377437401536
00020	343325352402	-100507152356	226553511373	-044713573060	350512146720
00030	-131733776006	261573111021	-013077703463	213073245046	-103076267563
00040	-170601041565	055525171367	000742736513	-235775467374	317412164373
00050	203623302035	-027421223165	-364204755267	272255032707	321074712034
00060	-271556640544	243157016136	-267722446752	-111552100232	-375741461612
00070	103704226514	-105255742607	-145372107132	062322101212	156607021371
00100	-046371422157	043207051703	-115252056173	107402777653	-217076533435
00110	-060324110001	203075674747	346420200677	015222056652	166147371730
00120	353244715067	-073615725707	-276732110233	-202666150315	-312221166525
00130	213467303103	044663657066	153067222203	-336766740770	-311712612720
00140	-340332540132	-206557043411	-166323420753	263166764242	042513317720
00150	103533246661	-212377516423	122736273110	-002325516742	-355641126412
00160	212012172172	-2520440054051	111404154041	134060645711	-06733574060
00170	362663131753	040020070436	-151565603255	-114447526556	356206612370
00200	-030244002067	-127615420707	-171736205235	-314726407343	323661130025
00210	-337254013221	137365022370	347155672522	-262735506474	-154352347473
00220	-147431212457	-115650773204	-265320720476	-041130053216	-357076010435
00230	373270661504	306501211477	157065170727	366746364755	065474366561
00240	377730156404	-126140034377	-025512411620	-100245653554	254366727352
00250	345106413643	-353502523225	021076435735	-246062300040	102755410474
00260	-025522720525	106646255730	-040275464462	-335655253034	133073142433
00270	346707640516	150311054632	110766521403	031662616165	-271553466073
00300	201765233702	001551360657	307230634704	-171140323477	-166213075521
00310	366652276745	-344704333354	-376320403351	167525315615	350511140017
00320	-346064202754	-164631056445	150113726346	-135657127563	-245122520452
00330	-267140575411	025045454455	205071153457	261014165007	124224057127
00340	-145174400561	232047670331	-314507675071	-234212716152	-272776050110
00350	166130273131	270734365374	-234643011566	203306402203	236436424263
00360	352477527763	176740234753	052373564533	-054737343623	-267001331112
00370	-056002436565	-234330023371	-161176245535	-170163573641	-237066110303
00400	006355223422	-037033435573	043330550757	-252240370277	304313500320
00410	204716426775	227411153704	232070517204	345004560001	-127115714047
00420	-364765606154	-256541703652	-305115115622	-226675201574	-3772313202573
00430	-315055332622	-216140753776	033104536214	-353150365104	-063722150200
00440	-236307312643	120304113226	211312436745	072045132154	234161614752
00450	-004617150723	160313211106	-144017162423	-170220251411	-316465655555
00460	-226723304126	072064055341	-125700440211	-247107440556	-231056323675
00470	326142610140	-072075100474	120413163673	105553663360	-154347765216
					-221551565732
					356032657105
					-242556000310

Figure 16. First Thirty-Two Logical Data Records of Input for Sample Run

BINARY	TAPE 01224	RDS (00000)8	FILES	RDS (00000)8	RECCRDS
RECORD 00001	(01750)8	(01000)10	WORDS		
00000	000047651216	-047451415332	302134142107	041106646730	343642257265
00010	224711273517	-351327141643	000100163337	-326514762461	-015327210331
00020	-366522672125	141246004330	-314276150063	-223271753444	000164226054
00030	-316457646450	076257325710	004117547050	221016622110	341642251041
00040	301010144414	-312116606335	-044344677741	-231512765705	105402616612
00050	000241140712	-320262233565	214555112475	370437770776	364173745606
00060	000017715151	-134223711413	000301660137	165116322663	036151024144
00070	-272146532342	01332214320	-337421101352	-254643055226	000354053421
00100	-246340363064	352047501256	313703654666	105542172700	144035362334
00110	113715455422	063700364776	-241545721414	364524466514	-012331214105
00120	000501453065	205124603467	-052037235411	322542157053	201334770434
00130	030411447417	-152525302342	000510654544	332422365340	-051513635373
00140	-142534527061	-070600220224	-304351626317	33265353642	000551671772
00150	214571251457	364710242404	260254704074	351720136764	247070640057
00160	322707163216	025405725127	311121203452	-126435315522	160152323573
00170	000661413152	-350202245225	017776423335	243163421041	152264015101
00200	-266767716356	-205763121466	000710031216	-155416447135	-153246301543
00210	341264373754	-061435664447	056355371374	226131550072	000763021653
00220	366527245530	212727674770	-270166336130	377457323163	255720216051
00230	-165427710030	-114324572067	-056235112007	023716621435	-277247320643
00240	001034466434	-133402441525	031472033032	-331121077712	-052103756666
00250	-255343213240	231401473377	001135277334	-357121352323	163117511423
00260	-066541120637	076562670765	033052557672	016701126152	001155012347
00270	-142621274325	-213745001527	-225363200253	-072625176542	-326547115216
00300	367554615474	060430641771	-011101624537	-107721063264	-053001620564
00310	001244103214	-013220662311	137766501655	055654457161	332460575024
00320	-212641703337	007164242667	001245535014	-124024712514	-175440720511
00330	-271545302767	005224731414	235533631606	-151571374217	001263274153
00340	017004500714	-274752554005	211441017312	342463750166	147757565076
00350	146421506277	144237525023	234273266306	-101336352722	-040064317001
00360	001351010117	-113075710047	322114574574	001767167071	-245433747633
00370	-014012761020	-330537426751	001355776422	117031036572	-030306237743
00400	063372511460	253121323412	-276202226165	-070535642774	0014026611665
00410	114730741031	-030435231475	-143260700076	066765347014	-156603164413
00420	-010214232474	-220561363565	216643067066	-100202301700	-124167062131
00430	001546150215	-056332151720	270251637355	-144106244655	055033346060
00440	336274217707	106744535327	071727274660	161721600412	-165377722163
00450	-006423241126	260760243736	-137724210154	277777665051	001631531257
00460	-371707252243	146133671633	376015454422	-030174527374	-124201471364
00470	-011754637221	100223735766	136225065502	111701210652	-134163247026
					-033724163241
					-310131501104
					076050027704

Figure 17. First Thirty-Two Logical Data Records of Output for Sample Run

	RECORD	COC1C	(C1750)E	(01C00)10	WORDS				
00000	04434037336	207047232256	-367713347673	260652567760	377244422214	000215123307	-073733424633	040272423720	
00010	120264721154	-150637551251	044364750727	110040205351	-206306257515	245674037621	044201250265	021223707666	
00020	-276524310601	-357473741146	-205170120457	215301551377	044462620425	-235414642234	-176722255425	024747731031	
00030	121313131773	-027755246662	-356072501733	051023730013	213317524176	321222222512	044477746136	225676237650	
00040	363132550005	-255364276014	-101177563411	262600777251	354250147017	017064564541	111077633010	134675372247	
00050	044620742077	-007634306221	351047545070	353045136727	310061656452	-260700075724	-037750035216	-110157167736	
00060	-367522453153	-220155427034	044654603521	377627031070	124365433427	-001145775655	-132565041655	-000047420156	
00070	114210156771	126420654236	-363766377455	-306453163361	044677172336	371700554451	-346752345220	-055205303755	
00100	-033025473355	224510055257	345064537501	-023636140450	347170610404	375504412201	044704131514	157260223611	
00110	050427006156	-236724656467	130235117407	355320530036	300267410256	150365671167	173507542516	-242510523631	
00120	044713212246	-115353325661	-305453724721	142213306661	-144416635522	-371306053302	272132052160	-056664476114	
00130	142774402706	-042642611725	044721532725	-115643610526	-313037727636	247633356346	214432573460	311662476212	
00140	-270451105572	-034571063244	236146612743	-007742607725	044723377653	351063274340	265660115177	-010073716721	
00150	-010477033163	-011602562352	364770556731	-043502225400	375371152032	-214611047305	044733743161	356077276123	
00160	-016741172012	-264661151065	375042310165	-222474322574	074504566567	337255653007	204571564732	252711434405	
00170	044750341116	046456721035	-005303565440	053041436377	123217762223	072613142606	-310217510323	-174322727512	
00200	140506500070	156200506524	044757154623	154655750407	-364574755334	305340040024	-161613040721	-207256055063	
00210	204412302145	-176536542350	372167572103	202570157471	045115730422	024476440775	-261722316400	-374054424334	
00220	156564031127	-006040116151	-144107610716	037304341426	-205511612545	-167434143346	045155535322	-022532565672	
00230	-211720673251	311434340721	-211341612365	-343764222767	-212674604707	241350326331	151614007474	132164260567	
00240	<u>045364030154</u>	-146130347644	-123374243534	212744050627	132060424151	136771203217	054050726244	-013361610037	
00250	334042301065	327773606673	045463215701	-000427306243	044071415532	-135614066207	-052625174727	126402635152	
00260	-212771607132	146710303204	102057765276	027357570610	045512645672	-172036356750	253663522100	166417053036	
00270	-365555012647	-305740443077	-054011413117	-167230253644	-165702615140	-212527617671	045524231454	-306073135546	
00300	003172776060	212716070010	275744212541	-147720007111	-064464236454	-322333343746	-046735731462	-050016454635	
00310	045527751656	117326213370	-252160321524	326771233517	101755232747	235231644772	060306222543	-241602434325	
00320	020076625235	363766201543	045717753376	051016177310	344147561643	-020250662031	361416601375	320706704703	
00330	104140736564	263352135560	-012740436011	-374644165054	045721275425	001742435025	044226021730	-360012422160	
00340	-144502634212	041532071072	-207117622051	331021063112	-177004140066	102253223106	045741613364	112357737763	
00350	-073214235647	233070472671	-046541063437	-244363000166	122467663503	304270216471	-253144060641	-350210117004	
00360	045750674171	-046256051235	257711130245	-074333443646	230236222562	226622773140	151116474575	-257004713101	
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00410	-116701711337	-022720635464	-137174130361	-266647532530	-270103141666	031340460677	046134704461	112602740625	
00420	-054767231731	-202473262373	-363270730757	310502307500	033076142735	155064713041	-026775371507	-030454115134	
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00470	-310767351103	-233764471466	137771111224	145510754404	306462563100	-315616103035	-241343511640	-075777770776	

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